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The What's New magazine

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APRIL
1982

Science reinvents the light bulb

Keep your old car—or sell it?

NASA's new radial turbine/diesel aircraft engine

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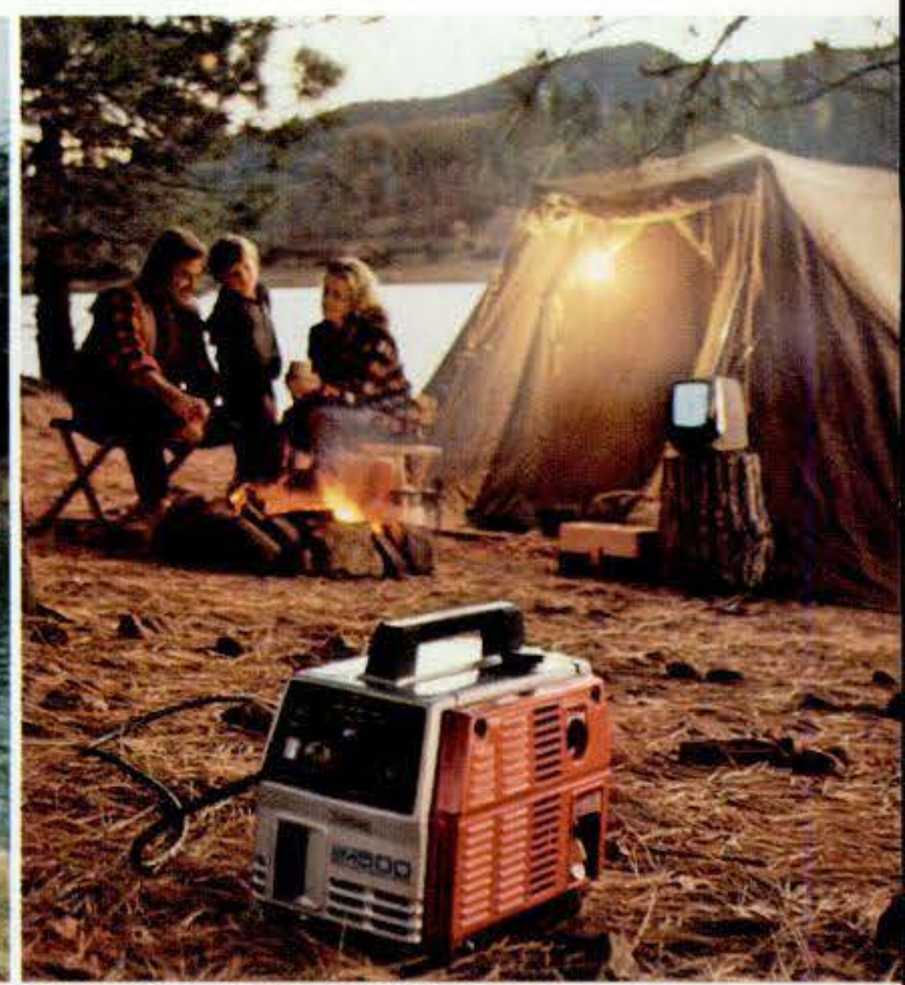
POWER TO GO.



The Honda EM-500 portable generator is really going places. The mountains. The lake. The desert. Out to sea. Anyplace people need to power camping accessories. Charge their boat or RV batteries. Run small tools or appliances. Or shed some light on emergencies.

TRAVEL LIGHT

You can carry the EM-500 anywhere. It gives you a maximum 500 watts of power in a lightweight 40 lb. package.

The EM-500's engine is a Honda. Designed and built by the people famous for engine innovations. And like all Honda engines, it's fuel efficient. It'll run up to 4 hours on half a gallon of gasoline.

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An Automatic Voltage Regulator gives you steady output to run appliances smoothly regardless of changes in engine speed and load.

Whether you need power in some far-away place, or just want emergency auxiliary power in your home, you'd have to go a long way to beat the Honda EM-500.

To see one, stop by your nearby Honda Generator dealer.

For the one nearest you, just look in the Yellow Pages, or call toll-free 800-447-4400. And in Illinois 800-322-4400.

IT'S A HONDA

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Popular Science MONTHLY®

The What's New magazine

APRIL 1982
Founded in 1872/Vol. 220, No.4

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PS READERS TALK BACK

Address letters for this column to: Readers Talk Back, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

Digitize me

Regarding your article on biomechanics [PS, Jan.], I'd like to know if the testing is available to the general public. I hope to play college football, and this kind of analysis could improve my chances.

Steven Orenstein, Irving, Tex.

The article refers to use of biomechanics to diagnose back injuries. As one who suffers with this chronic disability, I wonder if such equipment is medically available at this time. If so, it would be an important advance for both the medical and legal professions and would be in the interests of handicapped individuals.

Violet Swift, Orlando, Fla.

Daniel Ruby replies: "While biomechanical research benefits the public through application of its findings by coaches, equipment makers, physicians, and others, individual analysis remains too expensive to be widely practiced. This is due largely to the time-consuming process of digitizing from film. According to Gideon Ariel, the Coto Research Center would have to charge about $1,500 for a basic analysis if it were in that business for the general public (it isn't). The cost will come down when real-time digitizing (discussed in the article) is perfected."

Four colors suffice

Arthur Fisher is incorrect in stating that the four-color-map theorem (any map can be colored with only four colors such that no bordering countries are of the same color) has resisted proof to this day ["Science Newsfront," PS, Jan.]. Kenneth Appel and Wolfgang Haken of the University of Illinois proved it in 1976. However, since their proof made extensive use of computers (taboo for the pure mathematician), many have questioned their method. The questions now are: What constitutes a proof, and is use of computers legitimate in establishing mathematical theorems?

Mike Goodrich and Jack Veenstra
Grand Rapids, Mich.

No clone intended

The automotive ads these days seem to be constantly talking of econo-box clones and how to tell the "original" from the fake. Are we to assume that you were cloning around (pun intended) with the lead photographs in your February car test ["U.S. Economy Champs"]? The car you show as the Plymouth TC3 Miser is actually the Ford Escort viewed from another angle.

Richard T. Levow, Fresh Meadows, N.Y.

Our apologies: You really can tell the difference between the two cars. The real TC3 is shown above.

Theory and practice

Since thermal radiation has so much to do with the amount of energy we consume in making ourselves comfortable, it is good to see that products based on this phenomenon are reaching the market ["Insulating Wall Coverings," PS, Nov. '81]. I have some reservations about low-emissivity wallpaper, however. It takes only a very thin coating [of foreign matter] to spoil a low-emissivity surface. Over the years, smoke, dust, and organic vapors will condense on the wallpaper.

Also, atmospheric hydrogen peroxide will slowly oxidize the aluminum surface and its coating. Furthermore, these problems would be aggravated rather than alleviated by cleaning, which would abrade the surface and leave a

Continued

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Which is the lowest menthol 100's? (Hint: it's not Carlton.)

NOW is the lowest menthol 100s. But it's easy to see why some people aren't sure. They've had a lot of confusing numbers thrown at them for quite a while.

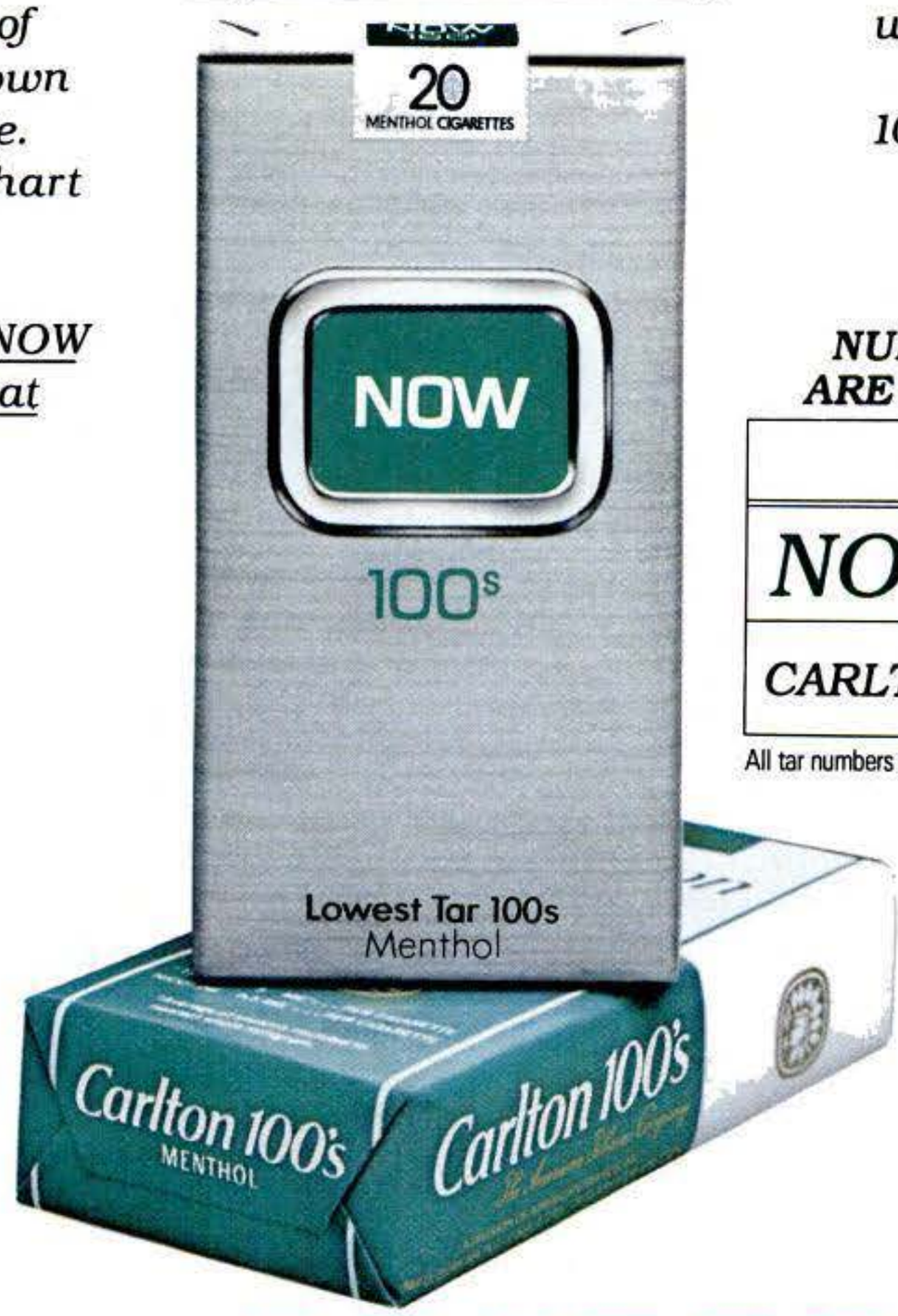
Just look at the chart at the right and see for yourself.

The truth is that NOW 100s Soft Pack Menthol at 2 mg tar contains less than half the tar of Carlton 100s Soft Pack Menthol at 5 mg.

And NOW Menthol 100s is by far and away lower in tar than any other Menthol 100s whatsoever.

Which is the lowest 100s menthol?

No need to guess-NOW.



NUMBERS DON'T LIE. NOW 100s ARE LOWER THAN CARLTON 100s.

	100's soft pack regular	100's soft pack menthol	100's box
NOW	2mg	2mg	Less than 0.01mg
CARLTON	5mg	5mg	1mg

All tar numbers are av. per cigarette by FTC method.

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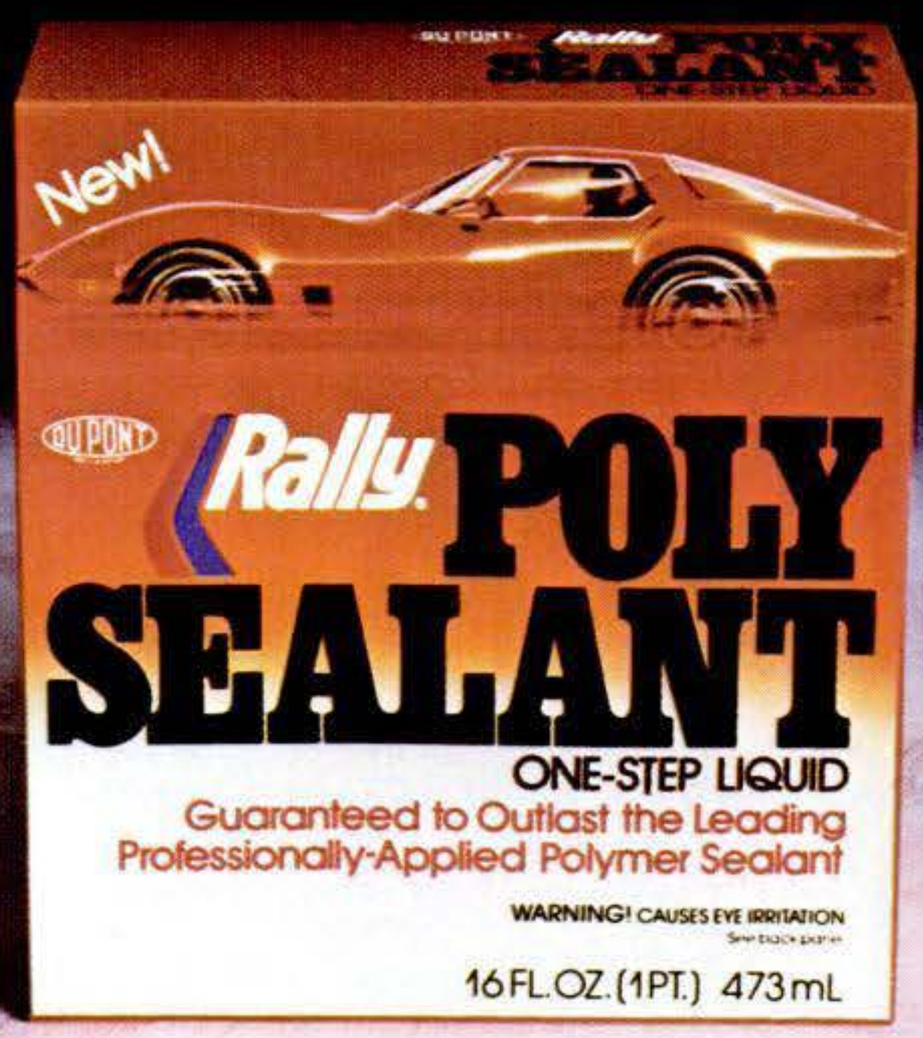

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Better Things for Better Living

PS readers talk back

[*Continued*]

soap film behind. Low-emissivity wallpaper is probably one of those great ideas that is just not practical.

Day Chahroudi, Petaluma, Calif.

Day Chahroudi was one of the scientists involved in developing infrared-reflecting Heat Mirror film (see "Wonder Windows," this issue).

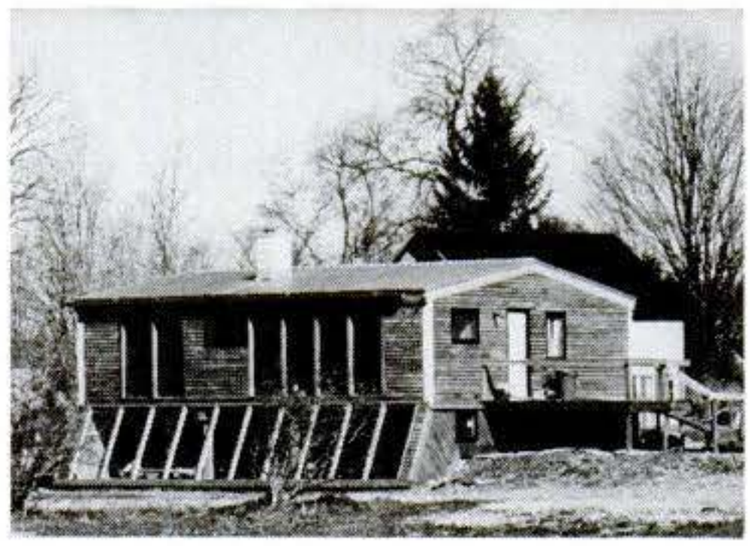
Seeing red

I'm glad that your auto editors were impressed with the red dashboard lights on the Datsun ["Mid-Price Sports Cars," PS, Dec. '81]. I'm not. After 10 years as a flight surgeon for F-4 fighter-plane squadrons, I still hate those red lights. In theory, they preserve night vision because the light-sensitive retinal cones, at the fovea, can't see them. Unfortunately, for all but the youngest aviators, most of the eye that can see red does so imprecisely. Newer fighters don't have red lights because at 600 knots clear vision is a necessity.

D. F. Ward, San Diego, Calif.

Seeing double

Your "Solar Flare" leisure home [PS, Jan.] has already been built. My house in Amherst, Mass., uses the same flared-base concept to increase solar gain (photo). With all its thermal mass (eight-inch-thick concrete foundation walls and four-inch slab), heavy insulation, earth berming, and solar gain, I am able to heat the house with wood only (just one cord last winter). Also, by keeping the plan simple and avoiding all those angles you have on the north side, I constructed it for just $29,000 plus land and my own labor.



Dan Reif, Amherst, Mass.

Hot glass

In the article on fireplace inserts [PS, Oct. '81], Auburn University's David Dyer makes the point that solid metal is more efficient than glass. Our ads for Phoenix Fireplace Inserts claim the opposite—and we can prove it. Tests by Corning show that when flames or coals are visible, glass has a heat-rate output 25 percent higher than steel or cast iron, primarily due to its high transmittance of infrared energy.

Junius D. Grimes III, MG Ltd., Asheville, N.C.

Engine origin

The article on stratified-charge engines [PS, Nov. '81] has its timing slipped. This type of engine may be 40 years old to Texaco in the U.S., but in England it goes back more than 60 years. The article says that engineering for the Texaco engine was contracted to Ricardo Consulting Engineers in England. It should have mentioned that the company founder, the late Sir Harry Ricardo, pioneered the engine back in the 1920's.

David W. H. Godfrey, Unionville, Ont.

Go to a pro

It is true that there are many people selling or packaging security systems who have very little training or expertise ["Shop Talk," PS, Sept. '81]. I suggest that any family or business considering a security system should contact their state chapter of the American Society for Industrial Security, which will supply a list of companies that meet ASIS qualifications. The system should also be reviewed or designed by a certified protection professional. The CPP after his name is a safeguard that he is qualified.

R. J. Solby, Lauderhill, Fla.

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Patent Pending

Airline Outrage!

New gadget in hands of passengers threatens airline revenues. Some airlines ban sale of Dynalite.

There's a real need. And we've got the product that fills that need, but we're having a rough time getting approval to advertise it.

The product is simply a headphone—the type that became popular with the introduction of the Sony Walkman. But this headphone is different because you can use it on an airplane to enjoy stereo music or movie sound tracks with more fidelity than you've ever imagined from an airline stereo system. But first, a surprise.

AIRLINE SECRET

Your airplane seat contains one of the finest audio systems ever developed. It's your airplane headphones that are lousy. Airline music is relayed from a central system into two separate miniature speakers located right in your seat armrest. In fact, if you put your ear close to the two speaker holes, you can hear the stereo music.

Your headphones, however, are not as sophisticated. They are simply hollow tubes transmitting the sound waves directly from those holes to your ear. It's a cheap, disposable, simple concept that has been a big revenue-producer for the airlines but an awful pain in the ear for most passengers. And the airlines have a monopoly. You can't plug anything but their crummy headphones into their armrests. Not until now.

SMALL AMPLIFIER

JS&A has developed a small amplifier called the Dynalite that plugs into the two audio holes of an airplane's armrest and faithfully amplifies the sounds. Now you can plug in a comfortable high-quality headphone and get beautiful stereo music without anything poking into your ear.

Not only will you be amazed at the quality you've missed, but movies will sound better than they've ever sounded before. Gone are the irritating rubber plugs, the rental fees and the necessity to take your own stereo recorder on board. You can now enjoy quality stereo music and outstanding movie sound tracks while you relax in your seat.

The Dynalite is simply a light plastic container with a short cord that plugs into your airplane armrest. There are two jacks on the Dynalite to insert up to two headphones. We offer a special collapsible travel headphone. However, any Walkman-type headphone will work including all those with a 3.5mm plug.

Once you plug in your unit, you adjust the volume on your armrest just as you normally would with the airline tube headphones. Then sit back and relax to the incredible sound that your airline always had but kept secret.

Do the airlines like people snooping in on their stereo music without their headphones? Some don't mind. But many of the airline in-flight magazines we tried to advertise in would not approve this ad. We suspect a few airlines are in an outrage over the Dynalite. Headphone sales make up a small chunk of airline revenues, and the airlines would lose this profit during rough economic times.

Some airlines might even get sticky and demand a rental fee for movies. Quite frankly, we doubt it but even if they do, you'll enjoy the movie much more than with their sets. And of course, the airlines do not charge for their headphones on shorter trips.

NOT FOR EVERYBODY

If you travel frequently, the savings in rental fees could quickly pay for the cost of the Dynalite. But what if you don't travel that frequently and how do you know if you'll like the unit? Simple. We'll give you two full months to try the system personally. If you take just one trip, experience and compare the difference between both the airline headphones and Dynalite. If you're not pleasantly and enthusiastically amazed and surprised, return your system and we'll refund all your money including the $3 for postage and handling. But what if you don't travel for two months and don't have the opportunity to test the system? Then the unit isn't really meant for you in the first place and you shouldn't have bought it.

The collapsible headphones weigh less than 2 ounces and fit comfortably over your ears.

If you're part of a sales organization, buy just one system and let the first salesperson who takes a trip report on the Dynalite. Or buy one as a gift for a friend who travels frequently. The Dynalite has two jacks so two people with headphones can listen through one unit.

To order your Dynalite, send your check or money order for **$39.95** plus $3 for postage and handling. (Illinois residents please add 6% sales tax.) Credit card buyers call our toll-free number below.

We'll send your Dynalite, 9-volt battery, instructions and a one-year limited warranty. Then take it with you on a trip anytime within the next two months. If it doesn't make a big difference in your next flight, return it within two months for a full refund including your $3 postage and handling charge.

FOLDING HEADPHONES

If you wish to order our completely portable and collapsible headphones shown below, also add $29.95. And if you order both the Dynalite and headphones, we'll throw in a handy carrying case that will conveniently hold both products when you travel, plus a six foot headphone extension cord that will let you plug your headphones into your stereo system at home. But there's more.

If you order two or more complete systems, your cost will be only $59.95 per unit—a great incentive to buy them for your special traveling friends.

We can understand the airlines' concern, but isn't it time you discovered what a great audio system they've got? Order the Dynalite at no obligation, today.

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PS car test & driving report

Ultra-luxury sedans
— smaller and thriftier

By JIM DUNNE
PHOTOGRAPHS BY JOHN KEATING

Give up luxury and comfort for better fuel economy? There's no need for that. Three of America's top prestige sedans for 1982—Lincoln Continental, Cadillac Seville, and Chrysler New Yorker—still promote luxury as their most important feature. But all three offer big improvements in fuel economy, too (turn the page for PS mpg test results). In addition, Continental and New Yorker are smaller this year, inside and out.

One startling fact when you compare prices of these three cars (page 10): The Continental and Seville are in the $25,000 class, while the New Yorker price is about half that. I found the difference difficult to account for, in terms of ride or comfort.

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Lincoln Continental	Cadillac Seville	Chrysler New Yorker
Acceleration	5	3	3
Braking	1	1	2
Handling	2	2	2
Maneuverability	5	5	4
Quietness	4	4	3
Roominess	4	4	4
Vision	3	2	4
Entry/exit ease	2	4	4
EPA economy	2	2	3
Ride comfort*	5	4	4

*Author's opinion

Continental is the newest design. Lincoln added this one-model series to the 1982 line as an unabashed compet-

Continued

Continental (foreground) borrows the bustle trunk of the Seville (middle). New Yorker (rear) costs about half as much as the others, a difference that's not apparent in terms of ride or comfort.

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THE TOYOTA 4-WHEEL-DRIVE TRUCK. THE CLASS ACT IN RUGGED 4x4's.

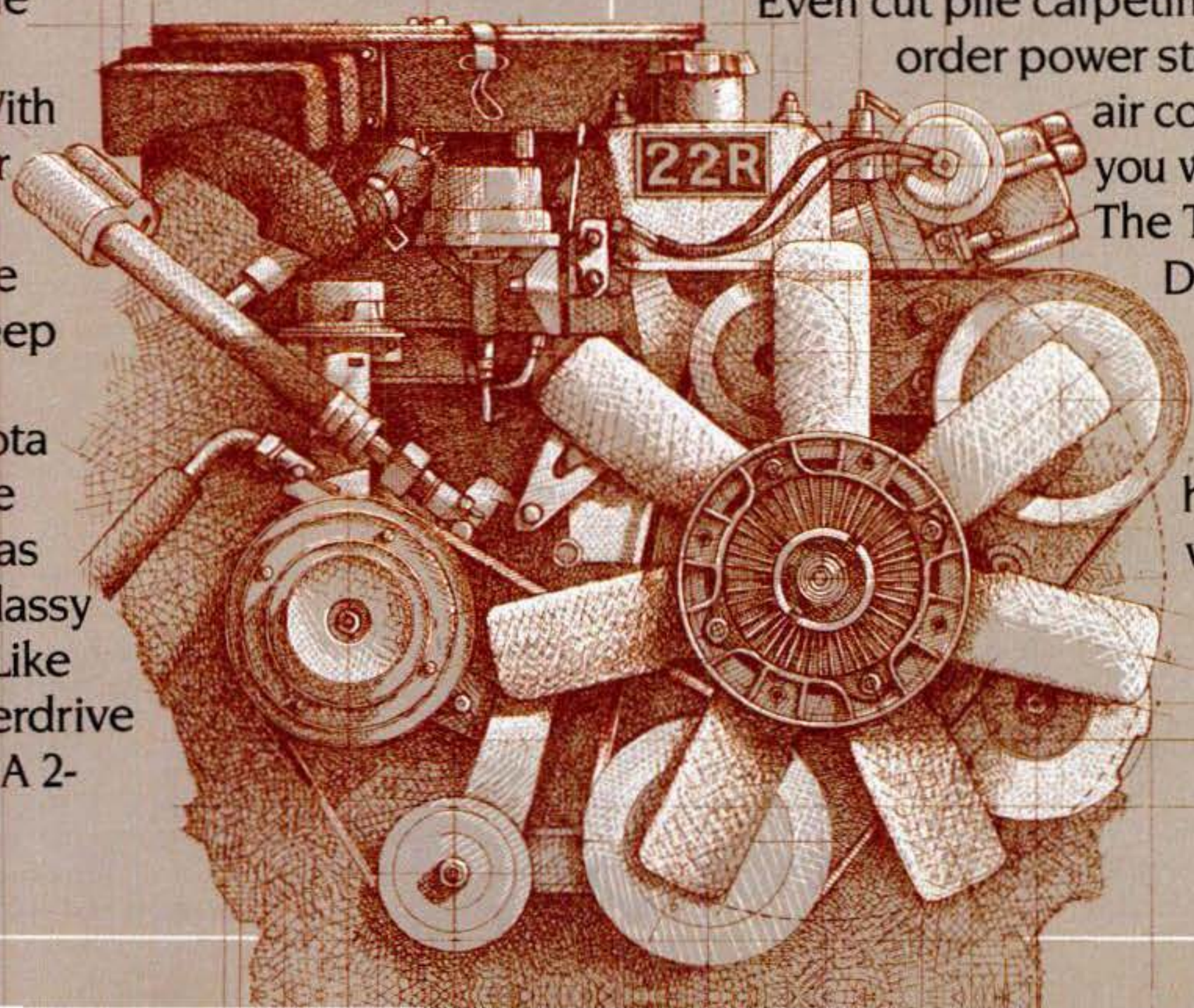
The Toyota 4-Wheel-Drive Truck has "class" written all over it! Under it, too. In fact, this 4X4 is built right, everywhere you look.

Under the hood, a big 2.4 liter 4-cylinder engine is standard equipment. With enough power to get you to the front of the class—and keep you there.

The Toyota 4-Wheel-Drive Sport Truck has lots of other classy features too. Like a 5-speed overdrive transmission. A 2-speed transfer case, for the right gear in any terrain. Free-wheeling locking front hubs. And a fully transistorized ignition system, so "class" starts on time! Whether you choose a Standard Bed or the Long Bed, you get a truck that'll carry 1,100 pounds of payload.

Inside, the Toyota 4-Wheel-Drive Sport Truck is a class act from door to door. With bucket seats. AM/FM/MPX stereo radio. Oil pressure and voltmeter gauges. Even cut pile carpeting. And you can order power steering and air conditioning if you want 'em.

The Toyota 4-Wheel-Drive Sport Truck. It has "class" written all over it. Because it has "Toyota" written across the tailgate!



Front-wheel-drive Cadillac Seville hustles through our maneuverability test. It, along with Continental, got top marks.

Chrysler New Yorker went through PS lane-change test at 56.9 mph, earning it a fair rating. The others fared similarly.

Lincoln Continental brakes from 60 mph. Stopping took 199 feet with hot brakes, a distance that gave it a poor rating.

itor for Seville (just look at the shape of the trunk for evidence). The sheet metal is all new and unique to Continental. But underneath, the chassis is familiar. In fact, the 108.5-inch wheelbase is identical to the Ford Fairmont's, and the Continental's suspension and steering systems are similar to the Ford compact's, as well. But the Continental has more sound insulation, a wider track, and more passenger space. It's all topped off with Lincoln's latest computerized instrument panel and more-luxurious seats and interior finish. The result is a different car overall, one that is fully competitive with the higher-priced Seville for ride, quietness, handling, and acceleration.

In our tests the Continental was markedly quicker than the Seville, as well as slightly quieter inside at highway speeds. At 30 mph the two cars were equal in our noise measurement, at 61 dBA. That level, surprisingly, was also matched by the much-less-expensive New Yorker. However, at 60 mph the New Yorker was 4 dBA noisier than the Continental and 3 dBA above the Seville, a major difference in both cases.

Cadillac has a new V8 engine this year, an aluminum type with 250-cu.-in. displacement. Cadillac wanted to get the best balance between fuel economy and performance with this displacement, but we found that the Lincoln's 302-cu.-in. engine delivers similar fuel economy plus performance that's markedly better.

In zero-to-60-mph acceleration tests the Lincoln averaged 14.2 seconds, while the Seville turned in 16.9. And at high speeds, the advantage of the Lincoln engine is clearer because the gearing in the Seville is designed for good performance at lower speeds.

Chrysler's venerable 225-cu.-in. Slant Six showed up in the test New Yorker, and that was unfortunate. It is overburdened in the Chrysler sedan chassis. The six struggles but barely manages a 21-second zero-to-60-mph time. The optional 318-cu.-in. V8 is strongly recommended. We suspect it matches the Lincoln in performance, and little will be lost in fuel economy. In fact, the 318 is on a par with the 225 in city driving and is rated four mpg better on the highway by the Environmental Protection Agency.

Lincoln is proud of its computer-readout system, which signals information such as fuel economy, miles to destination, average miles per hour in a trip, and other not-so-important data. To us, the system seems of little use in everyday driving. And it can be distracting because, when you use it, your attention is diverted from the road and focused on the row of push buttons and readout lights. Two years ago, when Lincoln's computer readout was new, it had great novelty. Today we question its real worth.

One feature that seems more valuable the longer we use it, though, is Lincoln's combination lock for doors and trunk. Lock your keys inside accidentally? No problem. Simply push the combination buttons on the door, and it opens. Push an extra button, and the trunk opens. In our experience with central door locks, we've found it's likely that keys occasionally will be locked inside. The combination lock saves a lot of time and trouble when that happens.

Lincoln Continental

Lincoln's full-size car of the future is here now in the Continental. Look for the regular Lincoln and Mark VI to shrink to this size in two years as Ford continues to build smaller, more-fuel-efficient models. Continental is a smoother-riding car than you would expect from the Fairmont chassis. The changes in the suspension and drive train that affect ride smoothness are noticeable and impressive.

EPA fuel mileage (mpg)

	Lincoln Continental	Cadillac Seville	Chrysler New Yorker
Highway	26	27	22
City	17	17	18
Calif. city	17	17	17

PS fuel-mileage tests
(steady-state mpg)

35 mph	35.3	34.7	26.9
55 mph	29.4	26.6	18.7

However, we found that the front seat does not fit as it should. It appears to be off center from the steering wheel, so the driver sits slightly sidesaddle. We found that it wasn't possible to get a "just right" feeling behind the wheel.

Digital speedometers may be the wave of the future, but we observed one major flaw in the Continental's. When driving on cruise control, the mph numbers flick constantly as the car automatically speeds and slows. That's distracting.

Cadillac Seville

What we haven't said earlier about Cadillac's new aluminum engine is that it's smooth and that if the 3,800-pound chassis were 500 pounds lighter, its performance would be just right. But Cadillac designed the fuel-injection V8 for models of the latter 1980's, so it will be a better performer in those lighter cars of the future. For now, it's only an adequate fill-in.

The engine has a twin throttle-body fuel-injection (TBI) system that differs from the port fuel-injection system used in earlier models. Most noticeable is the absence of momentary lag-then-jolt when accelerating

[Text continued on page 12]

For specs and test results, turn page

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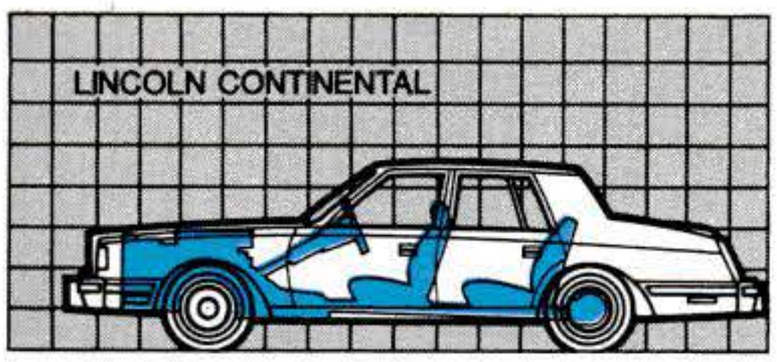

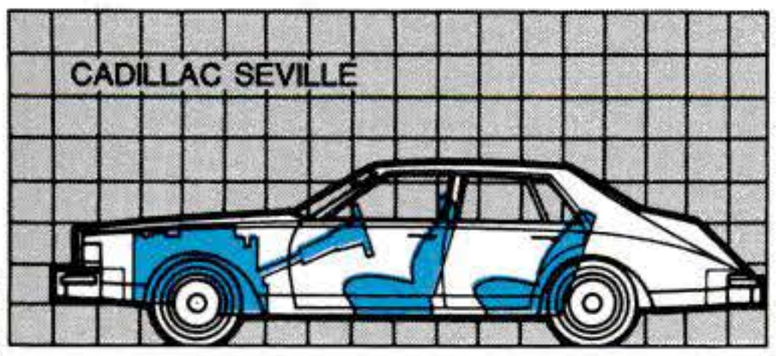

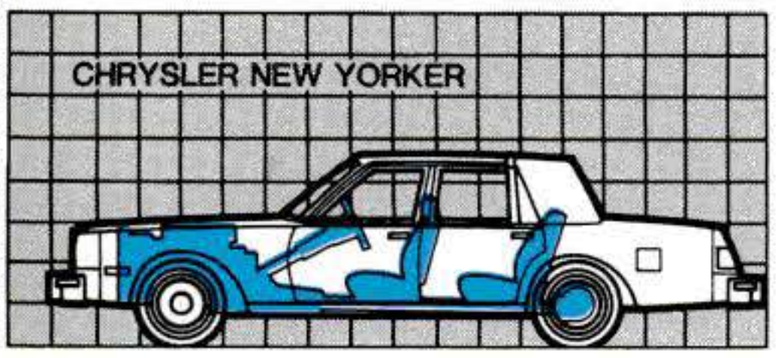

ILLUSTRATIONS BY RUSSELL VON SAUERS

In the lap of luxury: These three four-door sedans ensconce their passengers in plush interiors. Continental, with a 108.5-inch wheelbase, is smallest of the trio, but it's on a par with the others in roominess. Cadillac's front-wheel drive gives it the edge in front-seat room, however.

PS serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	Lincoln Continental	Cadillac Seville	Chrysler New Yorker
Checking fluid levels			
Battery	5	5	5
Master cylinder	3	3	5
Windshield washer	5	5	5
Engine oil	2	3	4
Coolant	5	5	5
Checking the engine			
Spark plugs	1	3	2
Distributor	1	1	1
Carb adjustment	*	TBI	*
Oil filter	2	3	3
Oil fill	1	4	1
Replacing hoses			
Upper radiator hose	3	5	5
Lower radiator hose	4	1	4
Heater hoses	1	4	3
Changing bulbs			
Headlights	3	1	3
Taillights	3	3	3
Front running lights	3	1	3
Front parking lights	3	1	3
Front directionals	3	1	3
Rear directionals	3	3	3
Rear running lights	3	3	3
Checking fuses	4	2	4
Spare-tire accessibility	4	2	2
Changing belts	3	1	2

*Sealed

Performance comparison with selected 1980 and earlier models

	Mpg (city driving)	Acceleration 0–60 mph (sec.)	Brakes 60–0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1980 BMW 528i 6	24	10.6	151	62.4	n.a.	65
1980 Cadillac Seville diesel V8	21	22.6	179	53	26.8	67
1980 Chrysler LeBaron V8	15	13.7	172	62.4	28.1	67
1980 Continental Mark IV V8	15	12.1	194	56.3	27.6	71
1980 Mercedes 300SD diesel 5	24	13.6	179	62.4	28.1	71
1979 Cadillac Eldorado V8	14	11.5	183	58.2	27.6	64

Lincoln Continental, Cadillac Seville, and Chrysler New Yorker—dimensions, specs, and test results

	Lincoln Continental	Cadillac Seville	Chrysler New Yorker
DIMENSIONS (inches)			
Wheelbase	108.5	114	112.7
Overall length	201.2	205.5	205.2
Overall height	55	55.2	55.3
Overall width	73.6	71.4	72.6
Track, F/R	58.4/59.0	59.3/60.6	60.0/59.5
Ground clearance	7.09	5.5	7.6
Front head room	38.5	38.1	39.3
Front hip room	52.5	51.4	56.8
Front leg room	42.8	42.8	42.4
Rear head room	37.7	37.3	37.7
Rear hip room	52.1	54.1	56.6
Rear leg room (min.)	37.2	39.4	37.4
Rear knee room (min.)	2.9	3.1	1.2
Couple distance	34.3	34.8	33.8
SPECIFICATIONS			
Engine type	V8	V8	In-line 6
Displacement (cu. in./L)	302/5.0	250/4.1	225/3.7
Compression ratio	8.4:1	8.5:1	8.2:1
Carburetion	2-bbl.	TBI	1-bbl.
Net hp @ rpm	131 @ 3,400	125 @ 4,200	92 @ 4,500
Net torque @ rpm	229 @ 2,200	190 @ 2,000	131 @ 2,500
Transmission	Four-speed automatic	Four-speed automatic	Three-speed automatic
Axle ratio	3.08:1	3.15:1	2.94:1
Tire make	Michelin	Goodyear	Michelin
Tire type	Self-sealing XA radial	Custom Polysteel Radial	XA
Tire size	P205/75R15	P205/75R15	P205/75R15
Steering	Power, rack and pinion	Power, recirculating ball	Recirculating ball
Overall steering ratio	Variable, 21.4-17.5:1	Variable, 15-13:1	18.7:1
Turns, lock to lock	3.05	3.0	3.5
Turn diameter (ft.)	42.6	42.2	39.5
Front suspension	Independent, coil springs on lower control arms, MacPherson strut	Independent, torsion bar	Independent, lateral, non-parallel torsion bars
Rear suspension	4-bar link, coil springs, upper and lower control arms	Independent, trailing arm, coil	Solid-axle Hotchkiss, semi-elliptical leaf springs
Front stabilizer-bar diameter (in.)	0.85	1.102	1.12
Rear stabilizer-bar diameter (in.)	None	0.866	None
Trailer towing (max. lbs.)	1,000	1,000	2,000
Trailer tongue weight (max. lbs.)	100	100	200
Brakes	Power, disc/disc	Power, disc/disc	Power, disc/drum
Brake swept area (sq. in.)	431	396	355.24
Fuel tank (gal.)	20	20.3	18
Trunk space (cu. ft.)	15	14.5	15.6
Liftover height (in.)	29.5	28.9	28.5
Curb weight (lbs.)	3,659	3,814	3,602
F/R weight distribution (%)	56/44	61/39	55/45
Basic price	$21,302	$23,433	$10,781
Price as tested	$24,456	$26,505	$12,962
Major options (over $100) on test car	Keyless lock $141, AM/FM stereo $107, garage-door opener $110, dual vanity mirrors $146, dealer destination $506	Door locks $145, seat recliner $150, 6-way passenger seat $282, rear defogger $198, vanity mirrors $136, cruise control $175, tilt wheel $169, puncture-seal tires $175, digital instruments, $229, AM/FM cassette $290, theft deterrent $179	Speed control $155, power seats $394, power locks $152, AM/FM/CB $364, wheels $271
TEST RESULTS			
Acceleration (sec.) 0–60 mph	14.2	16.9	20.96
Brake test (cool) 60–0 mph			
Stopping distance (ft.)	176	200	177
Pedal pressure (lbs.)	78	60	40
Brake test (hot) 60–0 mph			
Stopping distance (ft.)	199	192	170
Pedal pressure (lbs.)	50	40	60
Interior noise @ 30 mph (dBA)	61	61	61
Interior noise @ 60 mph (dBA)	66	67	70
Handling test (mph)	58.3	58.5	56.9
Maneuverability test (mph)	27.8	27.7	27.2

TEST CONDITIONS: Ambient temperature, 63°F; relative humidity, 57 percent; barometric pressure, 30.1 inches Hg

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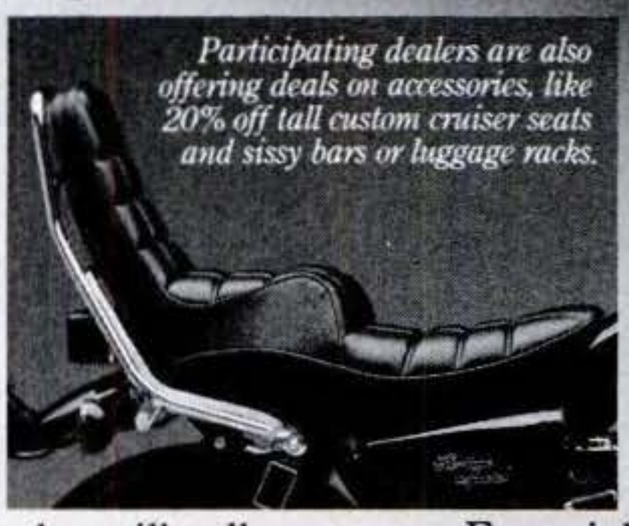
WE DISCOVERED A WAY TO IMPROVE THE HERITAGE 650.

Most people would have said that it couldn't be done. After all, the 1982 Heritage 650 has got quite a lot going for it.

The engine is our classic, reliable vertical twin. Combine that with the typically gorgeous Yamaha styling and you really couldn't ask for more.

But you could ask for less. So, from now until April 30th, your participating Yamaha dealer will sell you a Heritage 650 for the ridiculously low price of $1999.* And he's got equally terrific deals on Yamaha 650 Specials and Special IIs.



Participating dealers are also offering deals on accessories, like 20% off tall custom cruiser seats and sissy bars or luggage racks.

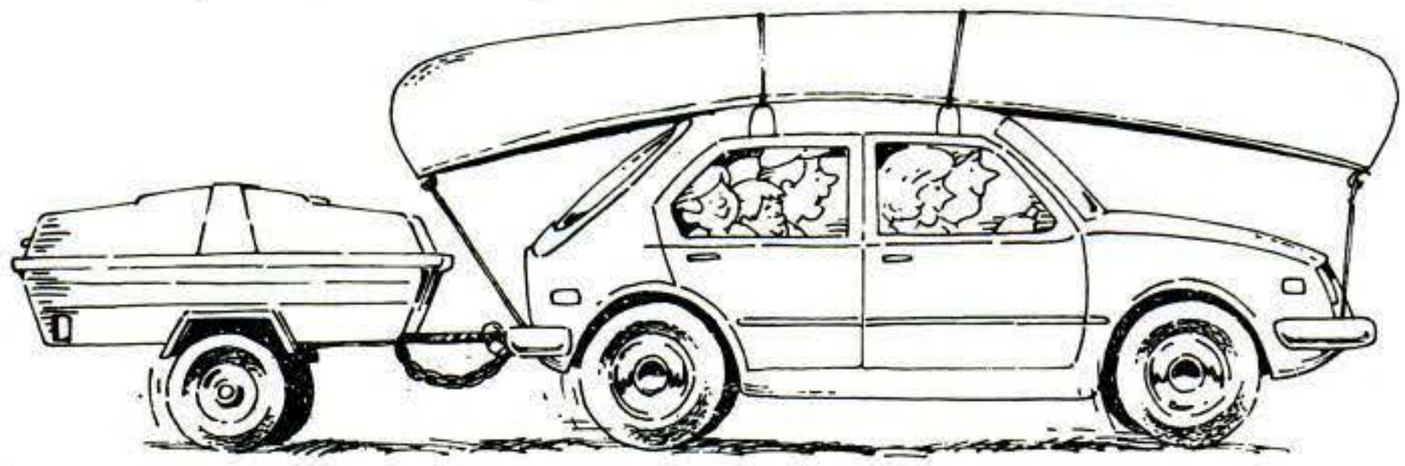
Of course, the supply is limited. So we suggest you get right down to your Yamaha dealer and take a look at all the 650 twins. Especially the Heritage.

The bike we improved with a felt pen.

THE YAMAHA 650 TWIN SALE.

*Manufacturer's Suggested Retail Price for XS650SJ. Actual prices set by dealers. Taxes, license, freight, options and other dealer charges extra. Prices may change without notice.

The compact problem.



The Coleman solution.

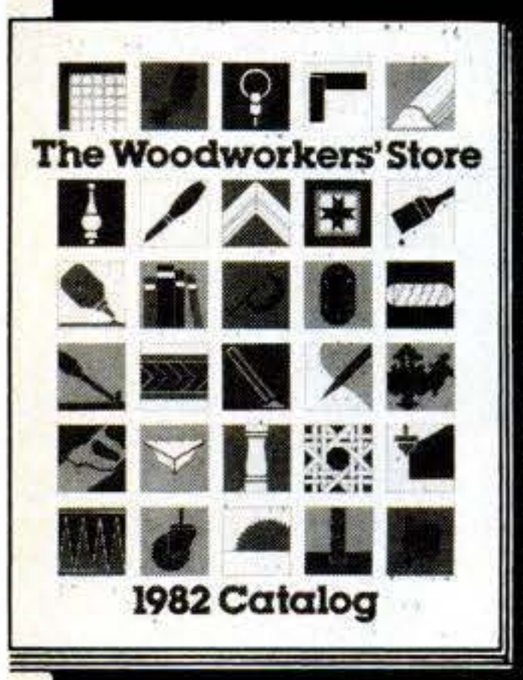
The problem with compacts is they *overpack* fast. Coleman's rugged PackHorse® II utility trailer is the perfect solution. PackHorse II can be pulled by any sub-compact and hauls over half a ton of suitcases, furniture, tools, toys—just about anything! Features include a full one year limited warranty, recessed taillights for easy on-end storage, easy-to-assemble kit and Coleman quality throughout. Handy options include a hard plastic top cover, cycle channel, floor and side board kit, tarp cover, spare tire, fenders, and cargo carrier.

See the PackHorse II utility trailer at your local Coleman dealer or call (814) 445-9661.

Coleman PackHorse II

One of a family of quality utility trailer products manufactured by the Coleman Company.

The Catalog



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from a standing start. And the engine speeds up smoothly, instantly.

The major driving difference between Seville and the competition comes from its front-drive chassis. The Seville has a heavier feel to the front end, and, overall, rides like a much heavier car than its competitors, even though the difference is only a few hundred pounds.

Seville offers a simpler information center than the Continental, with only three readouts in its Fuel Economy Data center on the instrument panel. You can get "Fuel Used" and mpg for instant and average driving times at the push of a button. We found the Cadillac readout system less intimidating and easier to understand than Continental's.

The current Seville has much more rear-seat room than the first version. It's almost spacious, and the problem of leg room is completely solved. Don't be fooled by that shaved-off rear end, either. The trunk has excellent load space. Seville's front-seat room is best in the class, thanks to the front-wheel-drive layout.

New Yorker

This is Chrysler's latest version of the Volare chassis the company introduced in the mid-1970's. The dress-up trim on the inside, especially the luxurious seats for the driver and front passenger, is impressive, but it can't hide the more humble origins of the Plymouth compact. That heritage is one of the most important reasons that New Yorker sells for half the price of Continental and Seville. Body, chassis, and drive train are designs that have been in production for years.

Chrysler dropped the full-size body from its lineup for 1982, so the New Yorker you see today is not the same as the one sold last year. The current model is smaller, lighter, more fuel efficient, and less luxurious—if you equate size and soft ride with luxury—than the full-size car it replaces.

Editor's choice

Make mine Seville because the high price, unique styling, and excessive ornamentation inside appeal to the snob in me. On the more practical side, I prefer the front-drive for the roominess it provides in the passenger compartment and the solid feel in the steering when traveling at high speed. The independent rear suspension may not make a noticeable difference in everyday driving, but it's evidence that Cadillac is serious about going the extra step to give its customers the best of everything.—J. D.

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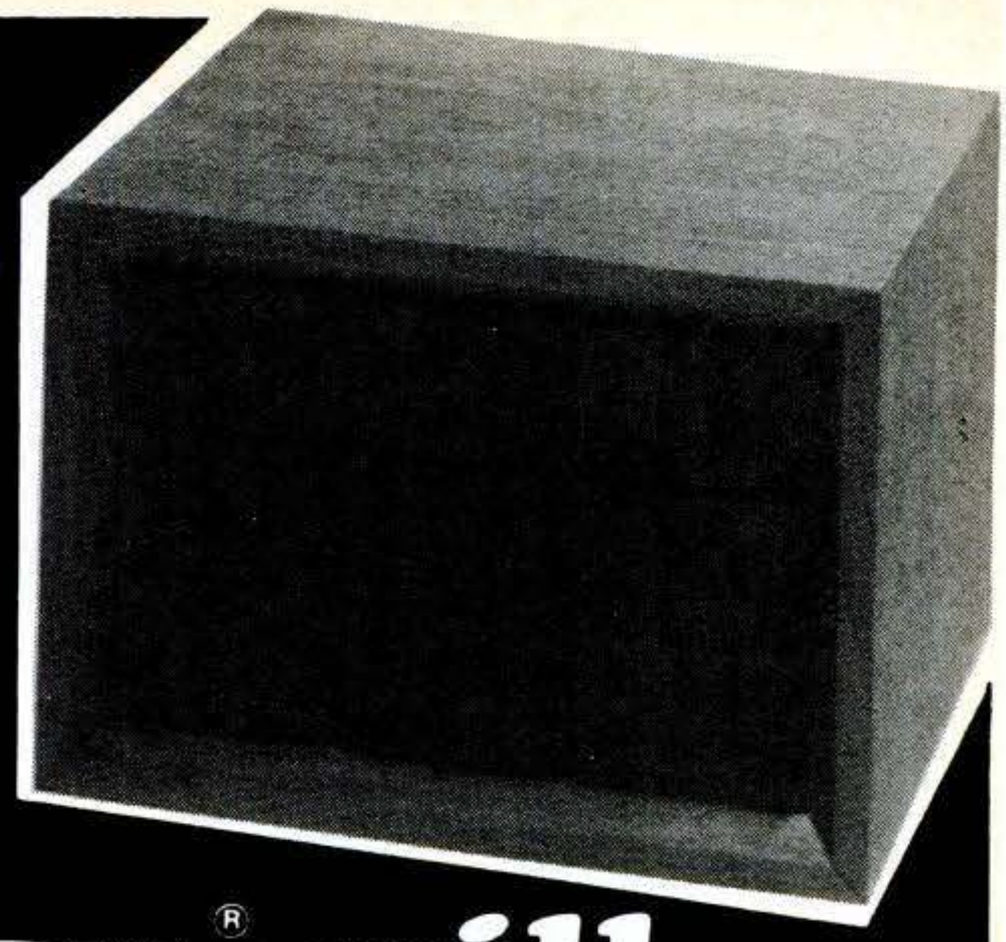
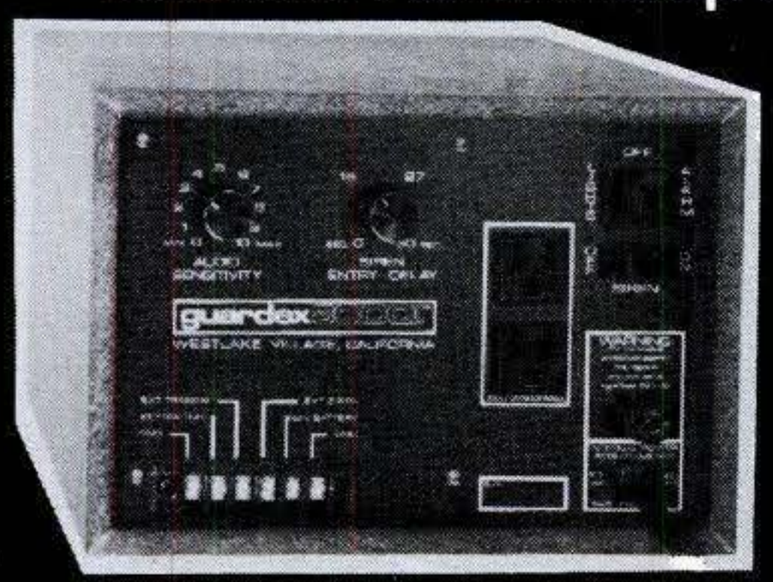
Glass won't discourage a burglar



...but guardex® will

Guardex Alarms stop burglars before they enter your home



Dealer Inquiries Invited

The Guardex 8000 Alarm System is walnut grain and disguised to look like a small stereo speaker (6¾" × 9¾" × 8") and weighs less than 6½ pounds. The rear view is pictured left.

NO INSTALLATION

Just plug the Guardex 8000 alarm system in, make two simple control adjustments to suit your particular building and it works! There are no other wires to run. This totally self-contained burglar alarm can completely seal off every square inch of the surface of your building. It protects doors, windows, and what most alarms miss... your roof, walls and floors.

A BURGLAR'S BEST WAY IN IS THE WINDOW

Guardex 8000 Alarm System works on the principle of audio discrimination. This, put simply, is the process of electronically separating normal everyday sounds, such as voices, telephones, etc. from break-in type noises such as breaking glass, prying metal, or forcing a door open. The Guardex 8000 protects one story homes and offices up to 2000 square feet and open commercial buildings up to 10,000 square feet. The Guardex 9300 with wireless remote sensor capability is available for multi-story homes and offices or single story with more than 2000 square feet. Call the factory for more detailed information.

PROTECT EVERY WINDOW AND DOOR

When the first break-in type sound is detected, the system will instantly turn on lights, radio, or other electronic equipment that you have plugged into the back of the alarm. These lights or other equipment will remain on for a period of five minutes, then automatically turn off.

POWERFUL ELECTRONIC SIREN

The Guardex 8000 alarm is equipped with a loud built-in siren. If during the five minute period the lights or other electronic equipment has been activated, a second break-in sound is detected the built-in siren will start blasting for 90 seconds. At the end of approximately 90 seconds the siren will shut off and the alarm listens again. If another break-in sound is heard, the siren will come on for another 90 seconds. If no other break-in sound is detected, the siren will stay off and at the end of the five minute period the lights will shut off and the alarm instantly resets.

BATTERY BACK-UP

Burglars rarely cut power. However, to give you total protection from a burglar and possible power failure, our alarm has provisions for a battery back-up. (Batteries not included). 12 volt lantern batteries are available at most hardware stores.

EXIT AND ENTRY DELAY

The Guardex 8000 alarm has a built-in exit delay allowing you approximately one minute to lock up and leave the building before the alarm is armed. When you enter your building you may find that just your normal entering sounds activate the siren. You may delay it from starting for up to 30 seconds by turning up the siren entry delay control.

THE BURGLARY PROBLEM

The F.B.I. statistics show that at the present rate, one out of every four Americans are going to be burglarized. That is not a very pleasant fact, but it is true. You have a greater chance of being burglarized than being a victim of a fire or automobile accident. The time is now to help protect yourself and your valuables with a Guardex 8000 alarm system.

WARRANTY

One year, 100% parts and labor when returned to factory postpaid. A five year extended warranty is available for a charge of $25.00.

OUTSIDE SIREN

The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from main alarm, they are available with 50 feet of wire for $29.95. (Connecting terminals are provided on the back of the alarm).

30 DAY NO RISK TRIAL

This is your opportunity to purchase an alarm system directly from the factory for only **$239.95**. Try it in your home or business for thirty days without risking one cent. Put our Guardex 8000 alarm to your own test. See for yourself! It will protect every window and door from break-in. If you are not completely satisfied, return the alarm within 30 days of receipt for a complete refund. To order your Guardex 8000 alarm, CALL TOLL FREE to charge your credit card or send your check to Guardian Electronics, Inc. in the amount of **$239.95** plus $4.95 postage, handling and insurance. If you want the optional outside siren, add $29.95. Optional outdoor 7" x 10" metal warning sign (stake not included) add $9.95. (California residents add 6% sales tax.) If you require more information, call during California business hours Monday through Friday.

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Antarctica's frozen fossils
give clues to continental drift

Giant, six-foot-tall penguins lie about on Seymour Island. Whales, sharks, and strange deep-sea reptiles are also beached on the shores of the bleak Antarctic island. They're all dead, of course, the fossilized remains of marine life that once flourished off the north tip of the Antarctic Peninsula.

In February 1982, paleontologists from four universities arrived on Seymour Island and its two companions in the Weddell Sea, James Ross and Snow Hill Islands. "These islands are a Rosetta Stone," said the expeditions' leader, Dr. William Zinsmeister of Ohio State University. "They have the best fossil record in the Southern Hemisphere for the geologic period between the Cretaceous and early Tertiary periods [from 100 to 30 million years ago]."

What puzzle will the fossils decode? Researchers want to get a clearer picture of what happened during Earth's early history when those giant penguins and reptiles flourished in the Antarctic. Sometime during the 70 million years covered by the fossil record a super-continent called Gondwana ripped apart and splintered into huge fragments. The continent-size chunks slowly drifted apart—South America moving west and Australia and New Zealand floating north. Besides creating new land masses, the drift caused fundamental changes in the Southern Hemisphere, altering ocean-circulation patterns and changing the whole global climate.

The research team will search for clues to what happened to plants and animals during those tumultuous times. "This is the only place in the Southern Hemisphere with such a complete geologic record," Dr. Zinsmeister said. "There are an incredible number of well-preserved fossils."

This fossil treasure-trove was first discovered in 1974. The U.S.-Argentine research team that made the original discoveries found a great variety of invertebrates—fossilized clams, snails, and starfish—as well as the large vertebrates. The team also discovered fossilized tree trunks, some as large as three feet across. The frigid islands are now treeless, of course.

Despite the earlier exploration, this year's expedition will be the first major U.S. research effort on the eastern part of the Antarctic Peninsula. Besides the team from Ohio State, researchers have come from the University of California, Texas Tech, and the Colorado School of Mines. The group is traveling on the Coast Guard icebreaker Glacier, which left from Chile on February 14, 1982. The 310-foot-long icebreaker will take ice-core samples in the Weddell Sea while the paleo-rock hounds roam the island.

The scientists will not only be looking for fossil records to tell the evolutionary tale of continental drift; they'll be especially alert for any marsupial fossils. Finding even one would help support a current hypothesis about the pouched mammals' origins. Some paleontologists think the kangaroo and its mates originated in North America and traveled down through South America to reach Australia. If this great marsupial migration took place, it would have had to cross Antarctica—then a part of Gondwana.—*Susan Renner-Smith*

Challengers, A Reflection of Northwoods Craftsmanship

Take the Weinbrenner "Challenge." We don't think you can find a better made, better priced chukka boot anywhere in America! Here is the country's favorite style designed for today's active living. Outside, a smooth grain leather upper and a deep-cleated lug sole and heel provide all-weather protection and super traction. Inside, there's a padded collar and a cushioned Cambrelle lining of absorbent, breathable material to surround your foot in total comfort.

Next time out, look for the Challenger from Weinbrenner . . . the Craftsmen of the Northwoods.

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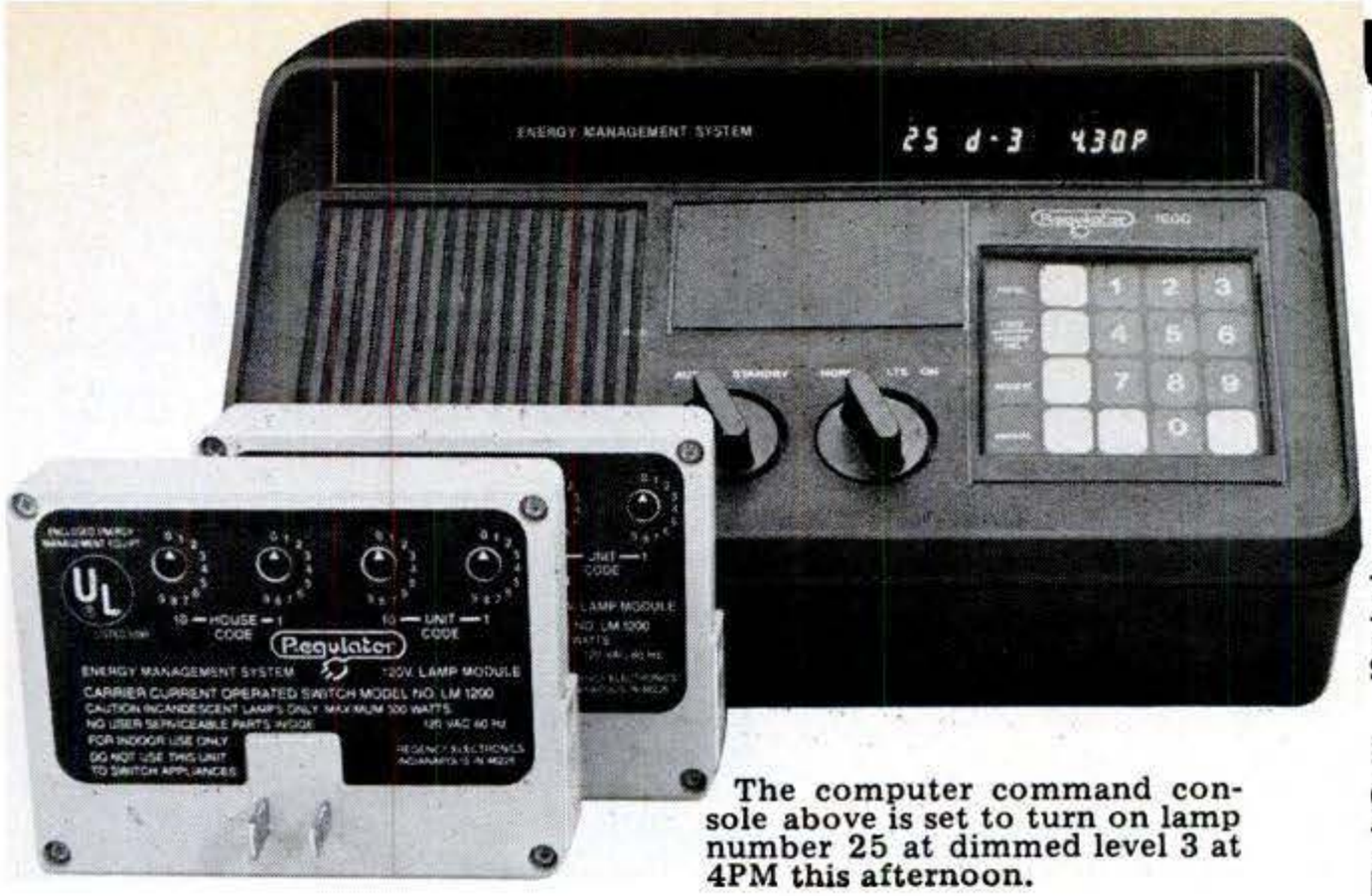

The computer command console above is set to turn on lamp number 25 at dimmed level 3 at 4PM this afternoon.

Ultimate Button

PRICE SLASHED

Was $149---We sold it for only $119

NOW JUST $69.90

With two free modules valued at $46.90

Regency has a problem. They built thousands of these computerized remote control systems they call the Regency Regulator to compete with the BSR X10 system. They built theirs to be much better.

The Regulator can handle up to 100 modules, the BSR only 16. The Regulator has 3 preprogrammed dimming levels you set and a quartz timing system that automatically directs 16 programmed functions per day. Unfortunately, the Regulator was priced higher than the BSR and competition is rough.

So through a one time large cash purchase, DAK has 1500 master command consoles on sale for the one time sale price of just **$69.90** ($6 P&H) Or. No. 9313.

EXTRA HOME BONUS—There's more. You get absolutely free one appliance and one lamp module to help you get started. Plus you can buy more modules with your order for the command console for 1/2 price. The Regulator is warrantied by Regency, and is compatible with BSR modules. Offer Limited.

Control anything electronic in your home with a preprogrammed command, or the touch of a button. Plus save on your heating and air conditioning bills.

Hats off to BSR. Their X10 remote control system started a whole new technology. Now from Regency comes the Regulator that gives you the ultimate control of your home.

Now you can remote control up to 100 lights and appliances, even those now controlled by a BSR system.

Plus, you can preprogram up to 16 daily commands to any of the controlled lights or appliances with the automatic quartz timing computer. You can let the Regulator take away daily drudgery or use it for security.

???HOW IS IT DIFFERENT???

The BSR system really started the field of remote control lighting. So, how is the Regulator different?

Number One Difference. The Regulator is an intelligent system. While you can manually turn on and off 16 things with the BSR and 100 with the Regulator, only the Regulator can also execute 16 daily preprogrammed commands without buying extra timing units.

You can have your outside lights come on 30 minutes before you are due home from work. Your heat or air can come on an hour before you return so that your home is comfortable.

Great Security—If you are away, you can have lights, radios, and TVs come on and off to give your home a lived-in look. You can even have lights come on and dim if you wish to save electricity.

Number Two Difference. The Regulator tells you what it's doing. It will display 'all on', or number 3 on 'dim', or whatever it is doing. Also there is a review feature that lets you review all preprogrammed commands. And, a standby feature that lets you leave preprogrammed functions 'on hold'.

Number Three Difference. The Regulator has a built-in three level automatic dimming circuit. You can select from the exact dimming levels of 55%, 30%, and 5% of any lamp in the system.

Number Four Difference. The Regulator has a heating and air conditioning module you can add to let you control the times your heat will come on. You can limit the heat at night and while you are at work during the day. But, you can still have the house at the temperature you want when you get up in the morning or come home at night.

SIMPLE INSTALLATION

Really there is no installation required. Simply plug the Regulator into any AC plug. Then plug in an inexpensive UL approved control module at any light or appliance you'd like to control.

The Regulator sends out commands to its modules through your own house wiring. So, there's never any wire to run. Plus your system is just yours, because there are 100 programmable house codes to choose from.

EASY TO PROGRAM

Each module is as easy to program as turning stations on your TV. Each module has a dial, numbered from 00 to 99. Simply set any number. When you push that number on the control console, the light or appliance will go into action.

LOCAL CONTROL

Even though a light or appliance is programmed into the system, you can still turn it on and off with its switch.

It is manufactured and warrantied by Regency, the Radio Scanner People.

1/2 PRICE MODULES

We are offering the two most used modules at exactly 1/2 Price.

1) Lamp Module——This is the module to use for controlling lamps pluged into the wall. It has 300 watt capacity, 100 codes and it has automatic 3 level dim. Retail $21.95, DAK sold it at $15.95. Now **$10.96**. ($1 P&H) Or. No. 9311.

2) Appliance module——This is the module to use for controlling appliances such as coffee pots, TVs, Stereos, and any home machinery. It has a 15 amp or 1/3 HP rating. 100 codes. Retail Price $24.95, DAK sold it at $17.95. Now just **$12.47** Order Number 9312.

SPECIAL MODULES

3) Heat and Air. This unit controls standard 24 volt thermostat wiring so that you can preprogram heat and air. This unit needs to be wired in by an electrician or yourself. Instructions included. Save on your energy bills. 100 code choices. Just **$49.95** ($1 P&H) Order Number 9314.

4) If you want to control a light that is controlled now by a light switch, such as patio lights or room lights, we have the basic BSR light switch. It only has 16 code choices, but other than that limitation it works perfectly with this system including the 3 preset dimming levels. 500 watt rating. Just **$19.95** ($1 P&H) Order Number 9217.

TRY THE REGULATOR RISK FREE

It's the professional system. It's built like a tank and it should last for years. If you already have a BSR system, it will be fully compatible.

Try the Regulator in your own home or office. If you aren't 100% satisfied simply return it in its original box within 30 days for a courteous refund.

To order your Regency Programmable Regulator risk free with your credit card call our toll free hotline, or send your check not for the $149 list price, and not for DAK's $119 old price, but send **only $69.90** plus $6 for postage and handling to DAK. Order Number 9313. CA res add 6% sales tax. Remember you also get 1 free appliance module and 1 free lamp module. It's an extra value of $46.90. Neither Regency nor DAK ever included a free module before.

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IF YOUR VIDEO INVESTMENT IS SHOWING DIMINISHING RETURNS,

it could be dropouts. White dots and dashes that spell trouble for your video investment. Before you blame your video deck, think about this. Tape passes over video heads that spin 30 times a second. With the wrong tape, friction can cause oxide particles to shed, leaving you with dropouts and other video headaches.

THE SOLUTION IS SUPER AVILYN.

Any quality videotape can look good at first. But wait until it's been played a few times. That's when one videotape really shows its worth. TDK Super Avilyn. It's made to prevail even under its severe working conditions.

Super Avilyn high energy tape particles are super refined. Their size and shape mean perfect alignment for high signal-to-noise ratio. They're densely packed and secured on the tape surface, which is polished mirror-smooth. The particles are there to stay. And so is your picture.

TDK's super precision mechanism keeps the tape running smoothly, with superb tape-to-head contact.

And Super Avilyn is remarkably compatible with just about any VCR you can buy. TDK supplies component parts, including video heads, to major VCR manufacturers. We know video inside and out.

Look. Once you know how your VCR works, you'll see that your video investment really depends on the tape. With TDK Super Avilyn, you'll see the dividends, again and again.

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THE VISION OF THE FUTURE

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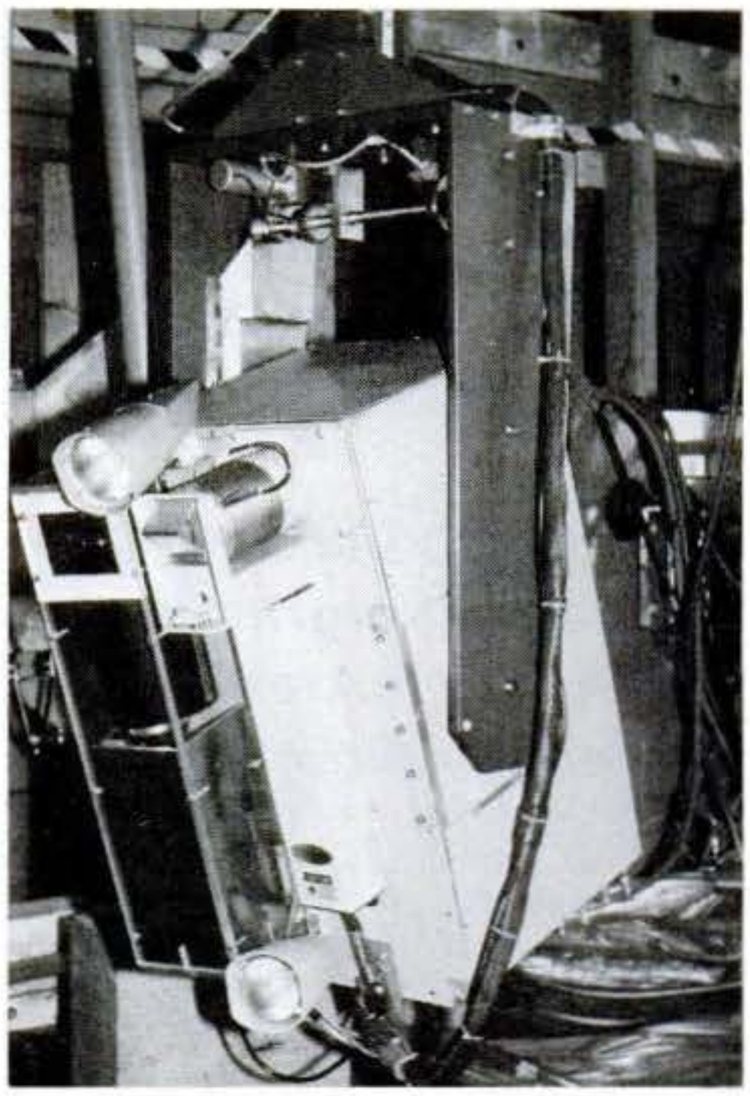
SUPER AVILYN

Remote weld watcher
for safer nuclear plants



Nuclear engineers can worry less about the "China syndrome," thanks to a new, remote-controlled X-ray machine. The MINAC/manipulator, or "miniature linear accelerator and manipulator," radiographs welds that hold together nuclear-plant cooling pumps.

A ruptured weld might—in the worst scenario—disable the cooling system, causing the reactor to overheat and "melt down" through its containment vessel—maybe all the way to China.

Previous attempts to inspect the welds failed—conventional X-rays and ultrasonics couldn't penetrate the pump's 11-inch-thick steel walls.

The new mini-accelerator produces high-energy X-rays powerful enough to penetrate pump walls. At 15 by 15 by 28 inches, the 200-lb. MINAC is small enough to be lowered into the pump. There, the remote-controlled manipulator tilts and shifts the machine so it can radiograph every inch of the welds—while the nuclear plant is operating.

Rochester (N.Y.) Gas and Electric, which developed MINAC jointly with Schoenberg Radiation of San Jose, Calif., recently tested the system at a 10-year-old nuclear power plant. Comparison of the new radiographs with those made when the plant was built showed the welds had not changed during the decade.—*Susan Renner-Smith*

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Dashboard model.

Under-the-hood model.

GUL SUPERHET. TODAY'S MOST AGGRESSIVE APPROACH TO POLICE RADAR.

Every day, the speed trap radar net closes tighter.

In fact, with today's new short pulse radar guns, a car can be clocked by police in less than two seconds. Under these tougher conditions a conventional radar detector doesn't have a chance to give you enough advanced warning.

Which is why GUL Laboratories developed a different kind of detection system. The Superheterodyne.

Passive versus aggressive.

The more common passive-circuit detectors have a limited range and little ability to discriminate true police signals over great distance.

The new GUL Superheterodyne has a detection range far beyond these passive detectors. And it gives you this advanced long range protection while virtually eliminating false alarms.

GUL's superior double conversion superheterodyne circuit selectively captures and amplifies weak or distant police radar signals. Similar signals that produce annoying false alarms in conventional detectors (from CB radios, FM stations and other microwave sources) are rejected by the new GUL.

The result is much earlier, much more reliable warning. Traveling at 75 mph, GUL would warn you 60 seconds earlier on X band and 30 seconds earlier on K band—compared to even the best passive detectors.

Like a geiger counter, GUL's red warning light and beeper pulse faster the closer you get to a police radar gun.

The City/Highway switch adjusts sensitivity for city or country driving conditions; and the green indicator light gives you visual assurance that the unit is operating properly.

GUL versus Escort.

In May 1981, the 5 leading superheterodyne detectors competed in a true-to-life road test conducted in Cincinnati, Ohio (home of Cincinnati Microwave, makers of the highly respected Escort). Presidents and chief engineers from all 5 companies attended.

The new GUL and Escort proved virtually indistinguishable in performance. Traveling at 75 mph—with the radar gun hidden behind a hill—GUL gave 67 seconds of warning time on X band. Escort gave 65. GUL provided 28 seconds on K band. Escort gave 29.

The other superheterodynes tested —Whistler, Super Snooper and Fox— finished far behind the leaders. They averaged 25 seconds less warning time on X. And 20 seconds less on K. GUL and Escort emerged from the test clearly in a league of their own.

Own the best. And hide it.

GUL offers you an important option that Escort doesn't: total concealment. The GUL Remote Model (pictured above right) installs under your hood in about an hour, using ordinary tools. It can be permanently wired to your car battery or plugged into your cigarette lighter. Its rugged diecast aluminum case is sealed against moisture and heat. Its remote warning panel (2 × 1") can be placed on visor or dash—neatly out of sight.

For easiest, most portable installation (or for two cars), the $229 dash model (left) conceals easily under a Kleenex box and saves you $70. With its rugged cast aluminum case (rather than plastic) it operates normally at extreme temperatures—from 4° below zero to 176° above. Attaches quickly to your dash with Velcro™, and plugs into cigarette lighter.

Both models measure 4 × 3 × 4" and come with full instructions and one year warranty.

Road test the new GUL for yourself. If you don't agree it's the strongest counter intelligence you can own, simply return it within 30 days for a prompt and courteous refund.

Call us now, toll free. Protect yourself with the newest, most sophisticated radar technology on the road today.

ORDER TOLL FREE.

Credit card holders may call our toll free numbers. Order product #GU623 for the GUL under-the-hood model: $299. Order #GU622 for GUL dashboard model: $229. Or send a check for the specified amount plus $4.50 delivery. Add 6% sales tax in CA. And please mention this magazine.

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THROUGH THE VIEWFINDER

By EVERETT H. ORTNER

Flash every time

On the proposition that flash rarely harms a photograph and almost always helps, three out of the four models in Kodak's brand-new line of instant cameras—Kodamatics, they're called—have electronic flash that pops every time you take a picture. Most of us tend to use flash only in the dark—typically, indoors at night. That's wrong. Flash is every bit as useful outdoors, and particularly in bright sunlight, to even the contrast between deep shadow and bright sunlight. It also brightens colors and puts details, that might otherwise disappear, in shadows.

The three cameras are also energy conserving: Thyristorized circuitry not only turns off the flash at precisely the right moment for a correct exposure, but prevents excessive power from being discharged when the flash is fired. (The excess capacitor power is not dumped, as it would be in an unthyristorized automatic flash.) All three (they're the upper ones in the lower photo) fold flat for carrying or storage. Pull up the lens section, as in the top photo, and the flash is automatically activated, ready for use. A manual override permits you to fire the cameras without flash.

At the top of the Kodamatic line is the 980L, which also offers automatic focusing. This system is built around an infrared light-sensing rangefinder. When you press the shutter release, the camera emits an IR beam that, reflected back off the subject, enables the camera to calculate the distance and move the lens into focus. An aperture blade with openings (f/11, f/16, and f/27) along with shutter speeds of ¼ to 1/150 second give this model a large range of exposure possibilities.

The top-of-the-line 980L lists for $115. The 970L, without automatic focusing but with a two-position lens that lets you take close-ups, is $93. The simpler model 960 is $78. And the Champ (center, lower photo), which doesn't fold or flash and resembles the old Colorburst cameras, now gone, is $30.

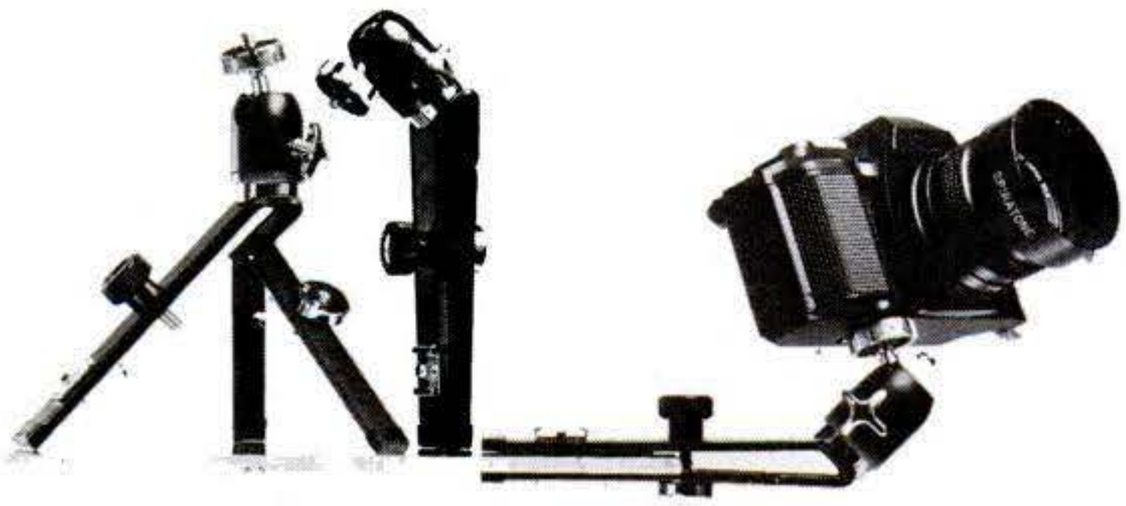
All take the new Kodamatic film, which is faster than the old film (ASA 320 vs. 160). You can use the old film in the new cameras in an emergency, but it's not recommended.

Serious bag

The Kiwi people call their CB-400 camera bag (photo at top) "the serious working bag." It's for the serious photographer who needs a bag capable of holding a serious amount of gear for a serious day's shooting. Among its features: light weight (2½ lbs.); an organizer insert, with Velcro attachments, that enables you to design the padded interior to fit your gear and needs; end-cap zippered pockets for film and accessories; and a tough, waterproof nylon exterior. List price: $80.

Tripod/clamp pod

You can clamp it to a car window or any panel up to 5/16 inch thick. You can open its three legs for table-top duty or snug it against your body as a chest pod. You can attach it, with camera, to your tripod, and mount a flash unit in its accessory shoe. Or . . . But you figure out other uses for the Multi-Pod. Its legs are flat steel bars tipped with rubber. It stands 5½ inches high. And it can be locked almost flat. Spiratone Inc. (135-06 Northern Blvd., Flushing, N.Y. 11354) mail-orders it for $19.95. PS



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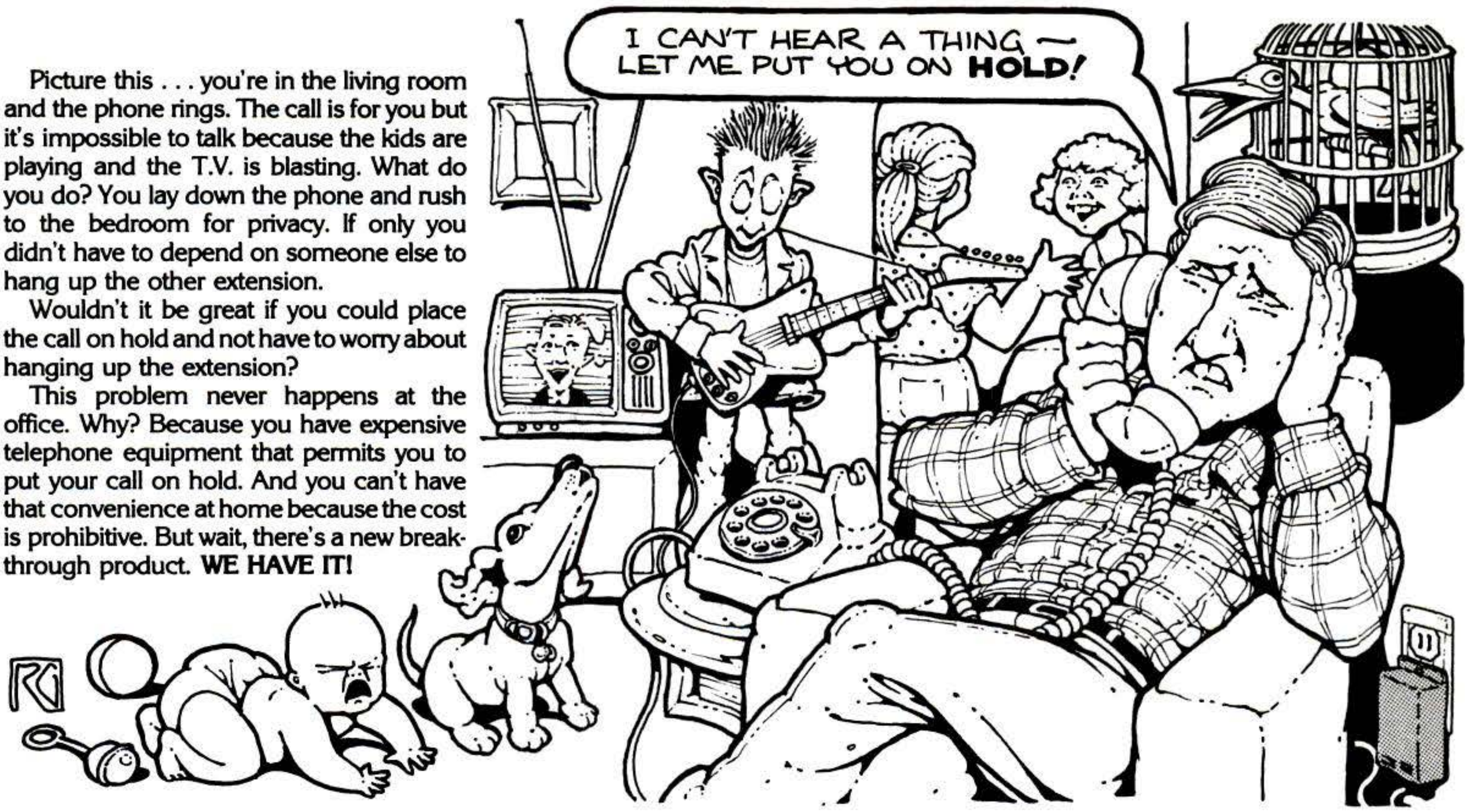
Picture this . . . you're in the living room and the phone rings. The call is for you but it's impossible to talk because the kids are playing and the T.V. is blasting. What do you do? You lay down the phone and rush to the bedroom for privacy. If only you didn't have to depend on someone else to hang up the other extension.

Wouldn't it be great if you could place the call on hold and not have to worry about hanging up the extension?

This problem never happens at the office. Why? Because you have expensive telephone equipment that permits you to put your call on hold. And you can't have that convenience at home because the cost is prohibitive. But wait, there's a new breakthrough product. **WE HAVE IT!**



UNIVERSAL HOLD™

HOME PHONE CONVENIENCE BREAKTHROUGH

We have the only telephone holding system that connects to your telephone line instead of the telephone itself.

Just plug it in. That's all! **No installation is necessary**. The Universal Hold™ plugs into any electrical outlet and nearby telephone jack. By flashing the switchhook twice, you have now placed the call on hold. A short series of tones indicates that the hold function has been activated and you are now able to hang up the receiver and resume your call at any extension.

WORKS GREAT WITH ANY SINGLE LINE PHONE

That's right, the new GTI Universal Hold™ system works with:

1) **ANY BRAND** (Bell System, ITT, GTE, etc.) and
2) **ANY STYLE** (Trimline, Princess, cordless, wall, etc.)

You only need ONE Universal Hold™ system to provide hold service for all the telephone extensions throughout the house.

The GTI Universal Hold™ system **will not interfere with your phone service in any way**. Absolutely not. In fact, it is compatible with all custom calling services (call waiting, three way calling, etc.).

"BUT I ONLY HAVE ONE PHONE!"

That's okay because the Universal Hold™ still provides a hold function. So, even if you only have one phone but have multiple phone jacks; after placing the call on hold, the phone can then be unplugged from one jack, and plugged back in at another location for you to resume your call.

NOTE: The Universal Hold™ is equipped with a six minute safety reset. In the event you place a call on hold and forget to resume your conversation, the Universal Hold™ will automatically disengage after six minutes to clear your line for incoming calls.

GTI Corporation, the manufacturer, has already received UL and FCC approval.

GTI is not General Telephone and Electronics Company (GTE) nor is it AT&T. GTI started out in the electronics business 25 years ago and has grown up with the electronics industry. We are an independent publicly held corporation listed on the American Stock Exchange. During that period of time, we have manufactured over 100 billion parts for such industry leaders as IBM, Hewlett-Packard, and Motorola. All of that experience has gone into our new call holding system. As a result, it's as reliable as your phone.

FREE TRIAL OFFER!

Because we are so convinced that once you have tried GTI's call holding system (Universal Hold™) you will want to keep it, we are offering a 90-day free trial period. Order it. Try it for 90 days. If for any reason you are not completely satisfied with the system, return it to us and we will refund your entire purchase price, including the $3.50 postage and handling charge—no questions asked. We are so certain of its reliability that we are able to offer an unconditional two year guarantee. If at any time within two years from the date of purchase your Universal Hold™ system fails, we will replace the system free of charge.

ORDER NOW

To order your Universal Hold™ send your check or money order for $49.95, plus $3.50 postage and handling, to GTI Corporation - Dept. PS482, 10060 Willow Creek Road, San Diego, California 92131-1699 (sorry, no COD's). California residents must add 6% sales tax.

MasterCard or Visa credit card holders may call our toll free number any time: 1-800-854-1521, in California dial 1-800-542-6247—ask for Dept. PS482.

IS OUR SYSTEM EXPENSIVE? COMPARE THE COSTS

	INITIAL COST	MONTHLY CHARGE	TOTAL COST 1 YEAR	TOTAL COST 5 YEARS
GTI SYSTEM	$49.95	-0-	$49.95	$49.95
AT&T SYSTEM	$185.00	$9.35	$297.20	$746.00

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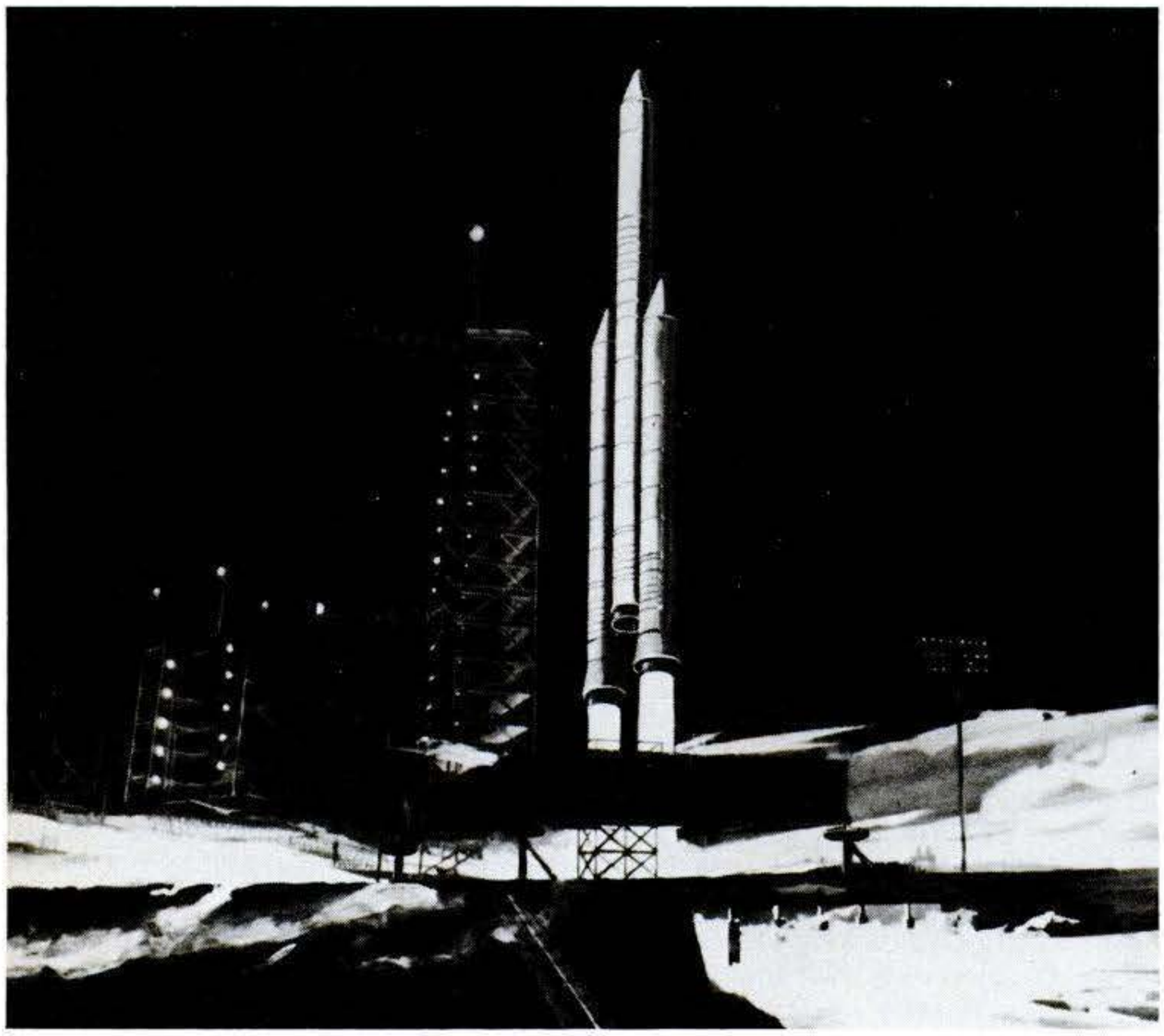
SCIENCE NEWSFRONT

By ARTHUR FISHER



Unmanned Shuttle assist

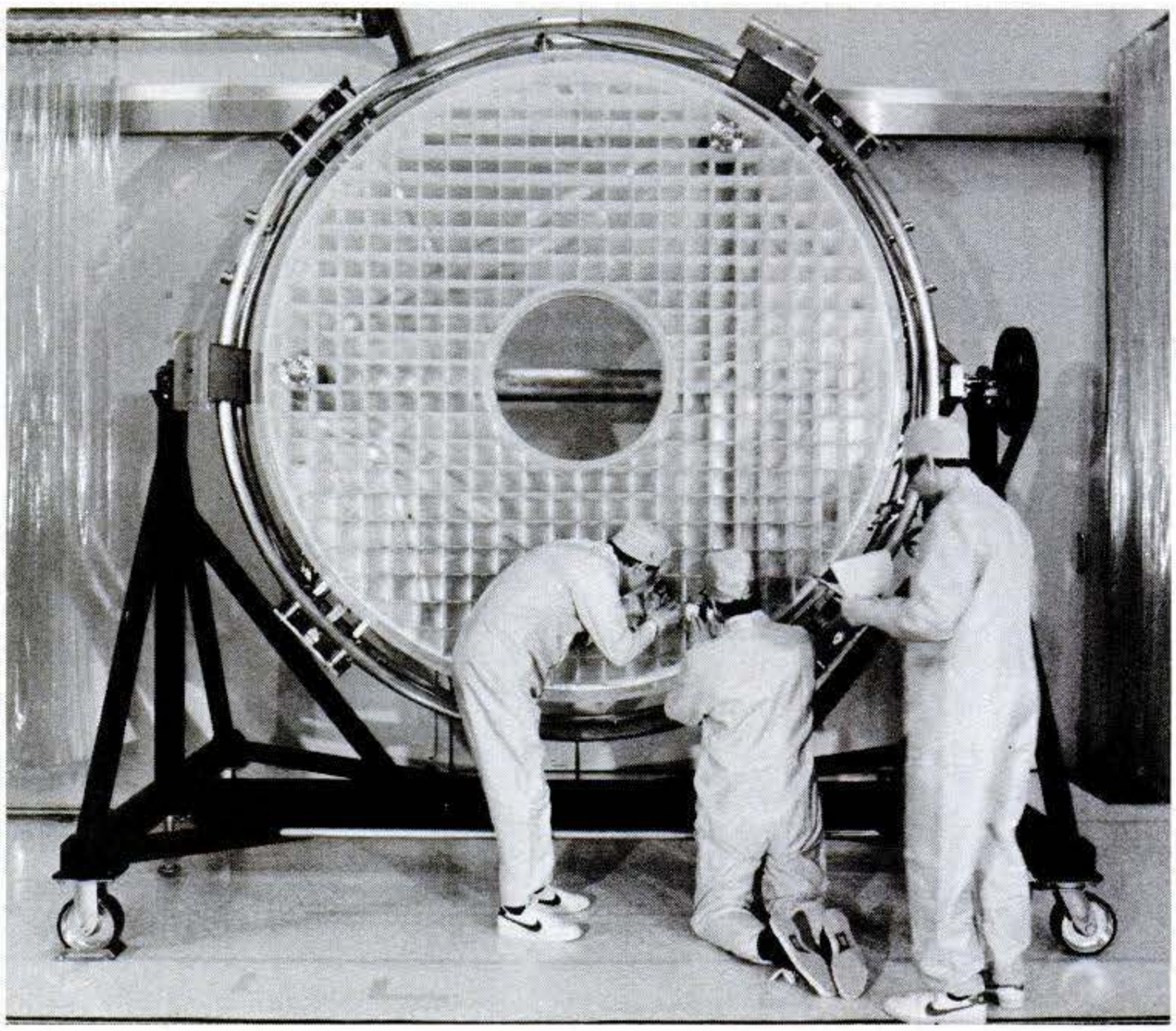
Engineers at Boeing Aerospace Company are studying a concept for a new, unmanned launch vehicle that would borrow the Space Shuttle's recoverable components and complement the Shuttle in a possible "mixed fleet" operation. The SRB-X, shown in the artist's concept above, would use the Shuttle's solid rocket boosters but not its orbiter or external fuel tank. It could be used to deliver payloads into orbit when space was not immediately available on the Shuttle. Various options are being considered: The three-rocket version in the drawing could carry 65,000 pounds of cargo into low Earth orbit, about 150 miles above Earth. The payload would be located at the top of the center rocket. After it had been inserted into orbit, the solid rocket boosters would fall back to Earth to be used again.

Space mirror

The 94-inch primary mirror for NASA's Space Telescope has been successfully coated with a special reflective surface by optical engineers at Perkin-Elmer Corporation. The mirror, which is shown at right being cleaned before the coating was applied, has a cellular structure, visible in the photo.

The coating consists of a layer of aluminum three-millionths of an inch thick, followed by a protective layer of magnesium fluoride one-millionth of an inch thick. A human hair is 1,000 times thicker than the two layers combined. The coating was applied in a stainless-steel vacuum chamber, largest of its kind in the world, according to John Kurdock, assistant director of optical development for Perkin-Elmer's Optical Technology Division. The chamber contained only one ten-thousandth as much air as the vacuum chambers in which the largest Earth-based telescope mirrors have been coated and tested. Nine computers controlled the carefully sequenced deposition of the layers.

When the 12-ton unmanned Space Telescope is completed and launched into orbit (now scheduled for early 1985), it will enable astronomers to study celestial objects 50 times dimmer than the faintest yet detected, and will penetrate as far as 14 billion light-years into space [PS, Oct. '81].



Synthetic blood vessels

After 15 years of intensive research, a team of polymer scientists at the University of Utah believes it has cleared the way for the use of artificial-blood-vessel implants in human beings.

The vessels are extremely narrow tubes—less than six millimeters in diameter, or about the size of a thin lead pencil—made from polyurethane, a polymer. (Polymers have very-long-chain molecules.) They could contribute greatly to the successful use of heart-bypass operations, in which surgeons replace a patient's damaged or blocked coronary

Continued

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SAVE $300

on 16-HP Garden Tractor (#25372)

$1699.99

Single lever controls VARI-DRIVE* to allow ground speed changes for efficient job handling. Many optional attachments available, such as work-saving 44-in. mower deck.

FEATURES:

- Twin cylinder, horizontal-shaft "in-line" mounted engine for smooth, dependable power.
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*Registered Trademark of Emerson Electric Co.

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Sweeper · 4-cu.ft. cart · Snow blade · Spreader/seeder

YOUR CHOICE
$899.99

10-HP Lawn Tractor (everyday low price)

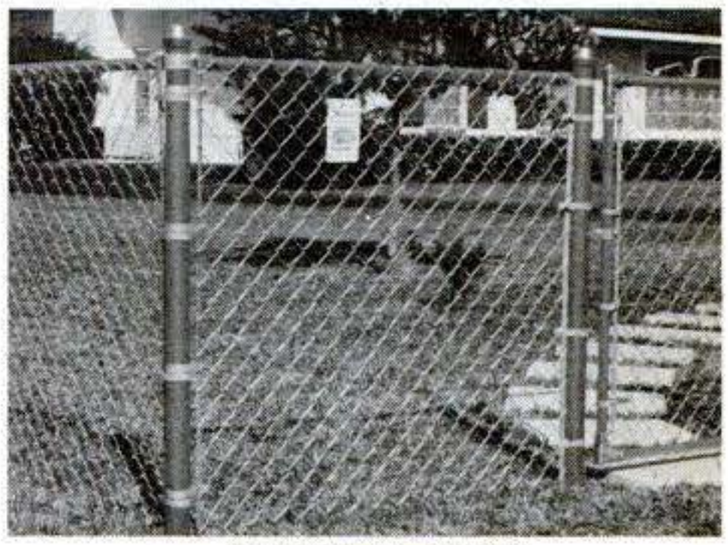
Key lock electric start engine. 36-in. "floating" twin blade mower deck. 3 forward speeds, 1 reverse. Automotive type steering and differential for easy handling and maximum control. (#25541)

SAVE $100

on 8-HP Riding Mower (Mower only)

Rear-mounted electric start engine. 30-in. single blade mower deck "floats" to help stop scalping. Five forward speeds plus reverse. Combination clutch/brake pedal for quick stops, easy gear changes. (#25612)

Self-bagger catcher (#26932) available at everyday low price of $199.99



SAVE 50%

on 11½ gauge galvanized steel Chain Link Fencing Fabric when you buy Armadillo® posts, top rails and fittings at Sears everyday low price.

Tough and beautiful Armadillo fence framework is triple coated to help fight off rust, corrosion and weather. 36, 42, 48, 60, and 72-in. heights available. (#9002)

Minimum savings nationally.
Prices and dates apply only to the continental United States.
Available at most Sears retail stores.

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HIGH ENERGY BILLS?
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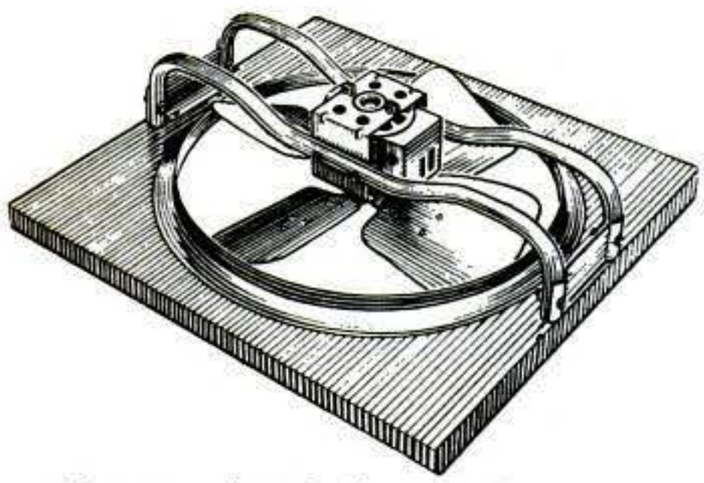
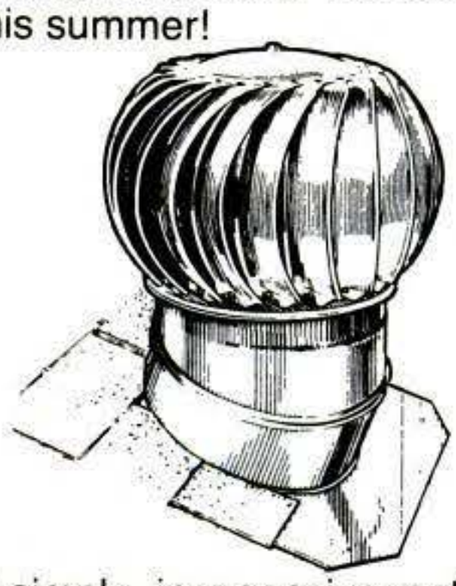
WITH EASY TO INSTALL HOME VENTILATION PRODUCTS FROM LOMANCO.



Remove hot indoor air from throughout the house and replace it with cooler air from outdoors at one-third the cost of air conditioning with an E-Z Breeze™ whole house fan. Quick and simple to install and maintenance free. Take it E-Z this summer!



A simple, inexpensive method to ease your air conditioner's workload is to vent your attic with a breeze-powered Whirlybird™ turbine. Easy to install and cost-free to operate, the Whirlybird™ is powered by even slight breezes, sucking hot air out of the attic as it turns.

FEATURED IN THE ENERGY SAVING HOUSE
THE 1982 WORLD'S FAIR
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This exclusive World's Fair trademark will appear on all Lomanco's ads for 1982.

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Science newsfront

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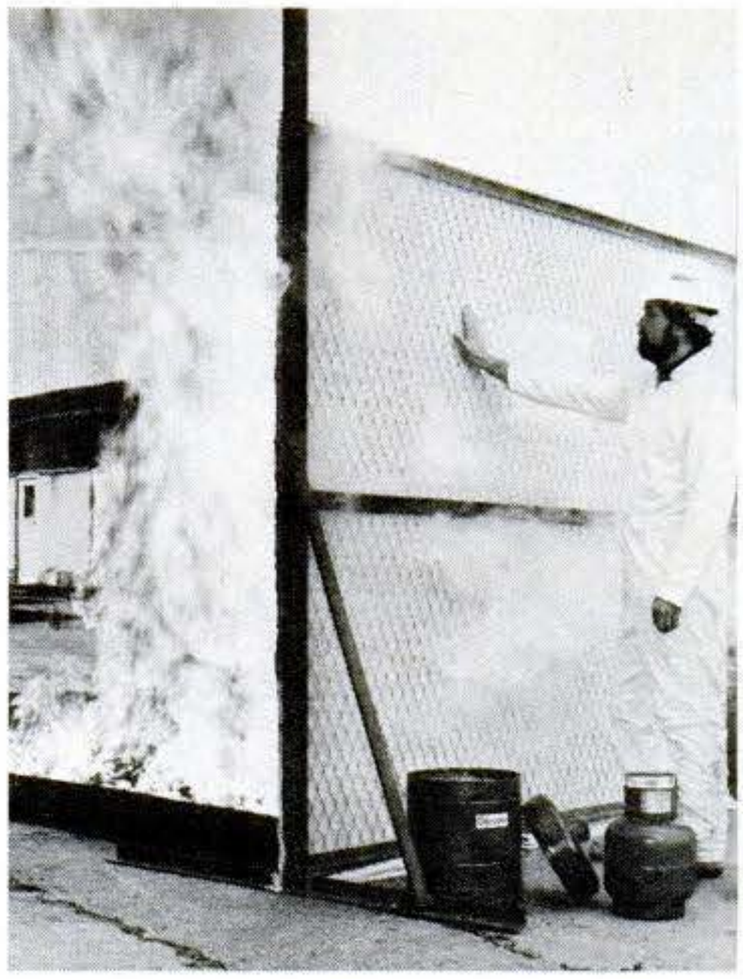
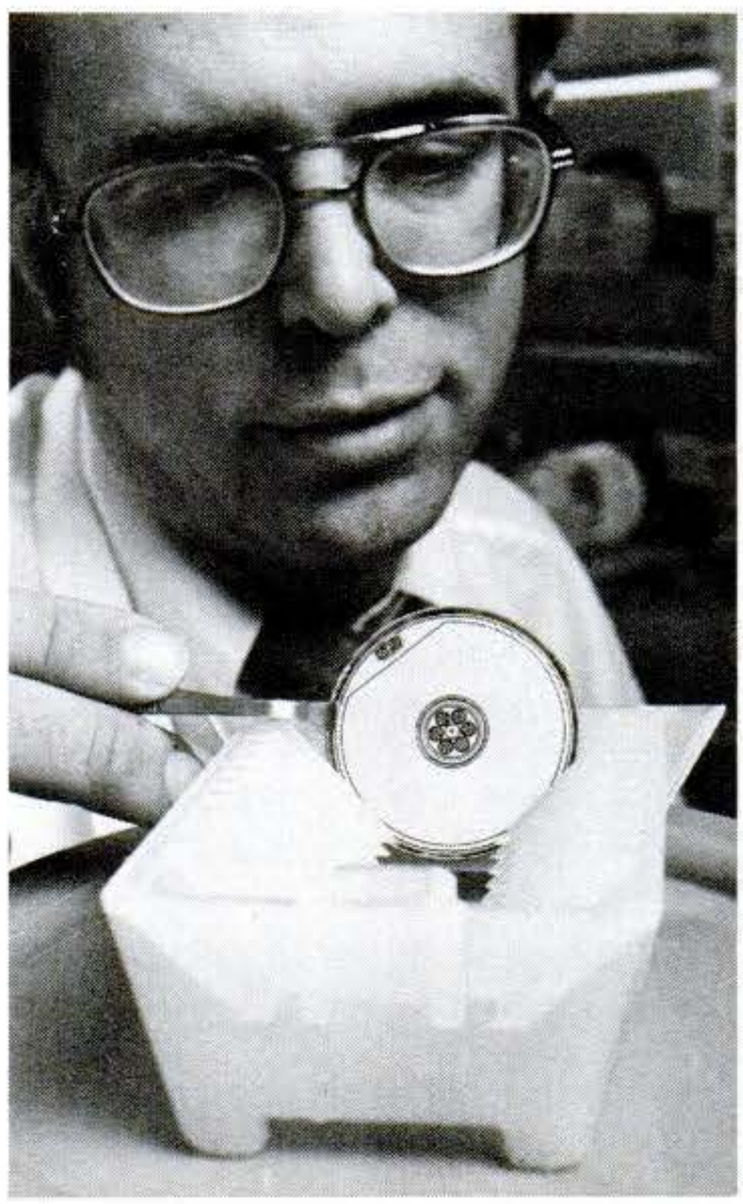


artery or arteries with a section of either of two large veins, the saphenous veins, which lie near the skin of the leg. Some patients complain that the removal of the leg vein is actually more troublesome than the heart bypass itself. The procedure also extends the time needed to perform the surgery, to as long as six hours. Moreover, some patients—10 to 25 percent—simply do not have saphenous veins of the right size or in good enough condition to qualify. So artificial vessels seem like a natural solution.

The main stumbling block, however, has been the problem of clotting in the narrow tubes. Dr. Donald J. Lyman, who heads the Utah team, reports that the problem was overcome by highly sophisticated basic research on the polymer material. Not only did the researchers have to develop the correct molecular structure for the implants—they also had to match the elastic properties of natural blood vessels. The present tubes both match the inner lining of the real thing and bend and pulsate in response to changing blood flow. Dogs that have had the implants for almost three years are doing well.



Dr. Lyman's group is applying to the Federal Food and Drug Administration for approval to use the implants in humans; a number of heart patients have already volunteered. Dr. Lyman notes that an estimated 300,000 patients per year can benefit from the artificial blood vessels, which could be used in treating peripheral vascular disease, as well.

Flexible fire screen

The dramatic photo at left shows the properties of a new fire-protection system developed in England by Blevex Limited. Called the Blevex Firescreen, it is made of expanded aluminum-foil mesh coated with a special paint that will blister and swell but not burn. When subjected to temperatures higher than 120 degrees C, the paint swells to fill the interstices in the foil mesh with a charred substance that is a good thermal barrier. Tests conducted by Britain's Health and Safety Executive have proved that the material can reduce heat transmission into storage vessels by as much as 95 percent. It is flexible, lightweight, easily cut, and can be used in as many layers as needed depending on the degree of protection required.

Magma power

Drillers at Kilauea Iki Lava Lake in Hawaii managed for the first time to penetrate a molten body hotter than 1,000 degrees C, recover a complete core, and maintain an open hole so experiments could continue in molten rock. The successful test, conducted by Sandia National Laboratories, together with earlier research, has convinced experts that it is scientifically feasible to extract thermal energy directly from magma—molten rock—that lies within 10 kilometers of the surface. The U.S. Geological Survey has estimated that such formations within the continental U.S. (primarily in the West) contain 800 to 8,000 times as much energy as the nation consumes annually. Sandia has managed the Department of Energy's Magma Energy Research Project since 1975.

Novel thyristor

This silicon wafer with the atomic design (photo, bottom left) is a new experimental thyristor, developed at General Electric Research and Development Center, that could significantly lower the operating costs of high-voltage direct-current (HVDC) power transmission lines being built in the U.S. and abroad. Thyristors are semiconductor devices that can switch and control large amounts of electric power in a few millionths of a second. The new thyristor is actuated by weak pulses of light carried over optical fibers, rather than by electrical currents. PS

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NO POWER ON EARTH BEATS THESE EPA MILEAGE RATINGS IN FULL-SIZE PICKUPS.

31 | 23

EST. HWY. EPA EST. MPG (CITY)

IT'S A FACT, BASED ON FULL-SIZE PICKUP FUEL ECONOMY ESTIMATES REPORTED BY THE EPA. AND THE NEW 6.2 LITER DIESEL MAKES IT POSSIBLE. It's available in full-size Chevy Pickups, Suburbans and 4WD Blazers, and it's designed specifically for trucks. This optional V8 is built to deliver the kind of raw power you need, without sacrificing economy. In fact, the new 6.2 Liter Diesel is so powerful that a properly equipped full-size '82 Diesel Pickup or Suburban can haul as much as 13,500 lbs., including itself, trailer, passengers, cargo and equipment.

And the 6.2 Diesel offers some very impressive mileage ratings:

	PICKUP		SUBURBAN		BLAZER	
	EST. HWY.	EPA EST. MPG (CITY)	EST. HWY.	EPA EST. MPG (CITY)		
2WD	31	23	30	20	–	–
4WD	29	22	26	18	28	20

Use estimated MPG for comparisons. Your mileage may differ depending on speed, distance, weather. Mileage will be less in heavy city traffic. Actual highway mileage lower. Some Chevrolet trucks are equipped with engines produced by other GM divisions, subsidiaries, or affiliated companies worldwide. See your dealer for details.

The new 6.2 Liter Diesel. It's 379 cubic inches of tough-towing, big-hauling, hardworking, fuel-sipping power. Our nearest sales competitor offers nothing like it at all. And where economy in a full-size pickup is concerned, there's not a power on earth that beats it.

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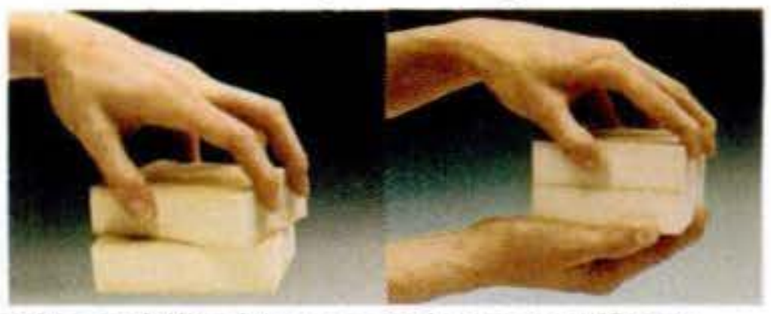
Specially made to penetrate both hard and soft woods, it grabs instantly, yet you can still realign the joint before it sets. After drying, it forms a bond that's even stronger than the wood itself.

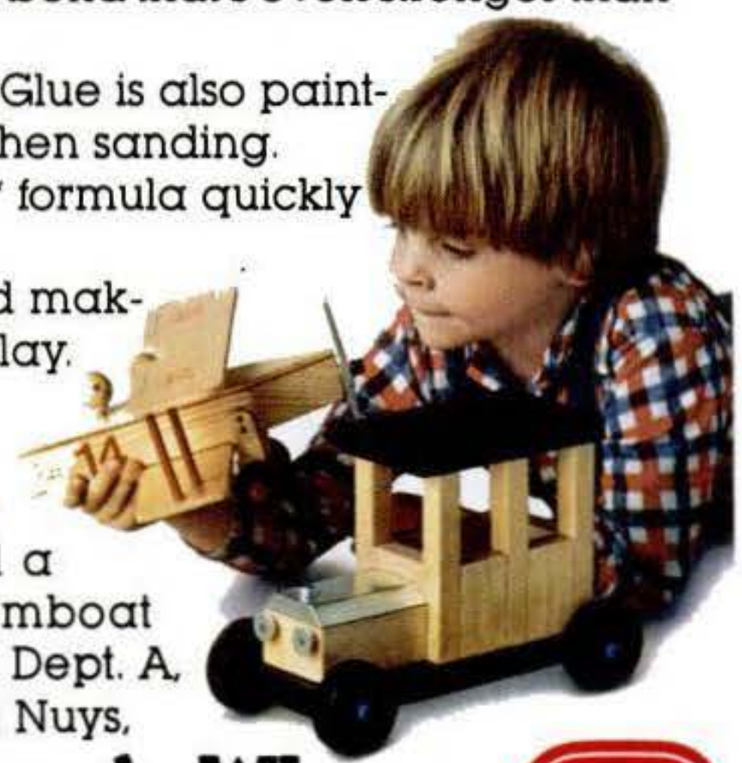
Grabs instantly Aligns easily



Elmer's Carpenter's Wood Glue is also paintable, resistant to gumming when sanding. And its solvent-free, non-toxic* formula quickly washes off with water.

To help make mending and making things like a pro...child's play.

For plans for making these beautiful wooden toys—the antique car, and biplane shown and a paddle-driven steamboat—send $3 to Elmer's, Dept. A, P.O. Box 2383, Van Nuys, CA 91409.



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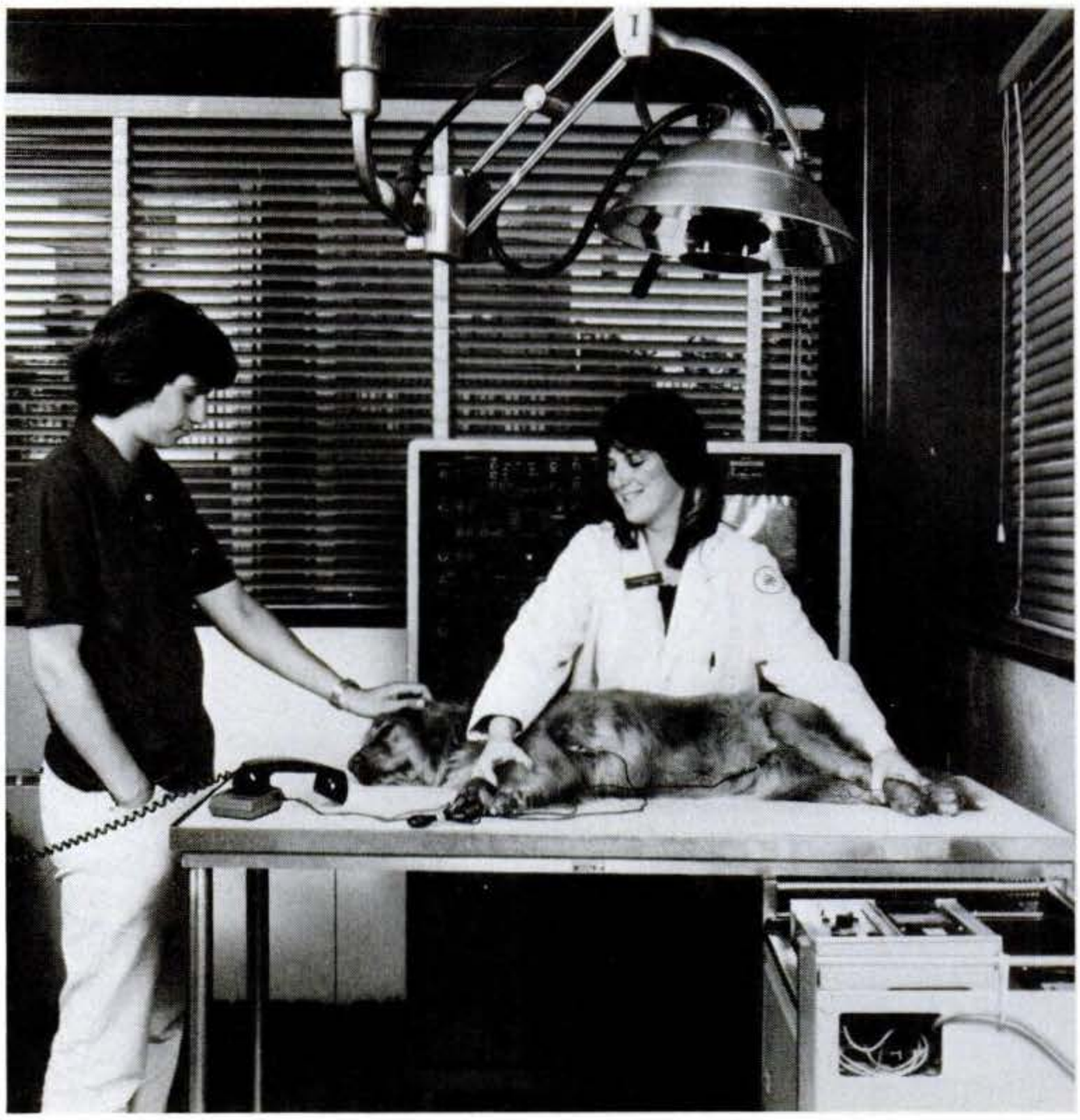
Animal heartline

for quick diagnosis of sick pets



No, the dog is not a guinea pig. Instead of testing the safety of a new medical device designed for people, the dog is using a device already tested by humans. The device? A simple transmitter attached to electrodes.

Pacemaker users routinely use the transmitter to send their heart rhythms, via phone lines, to a medical center for diagnosis.

The same instrument (under the phone in the photo) now can send the sounds of a sick pet's heart to the Cardiopet Center in Brooklyn, N.Y. There, an electrocardiogram is made and analyzed by experienced technicians, who diagnose the pet's problem and propose treatment. Often they suggest—you guessed it—a pacemaker.—*S. Renner-Smith*

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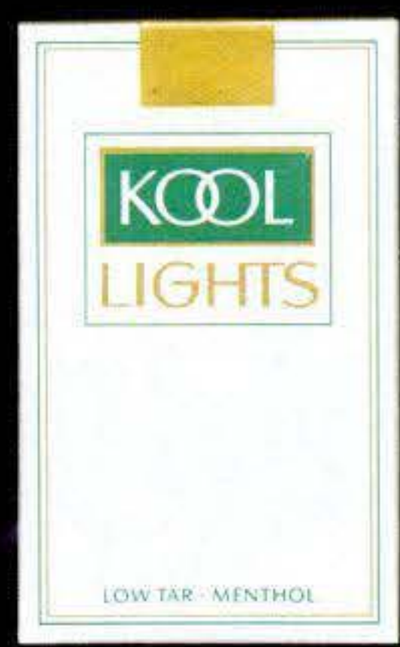

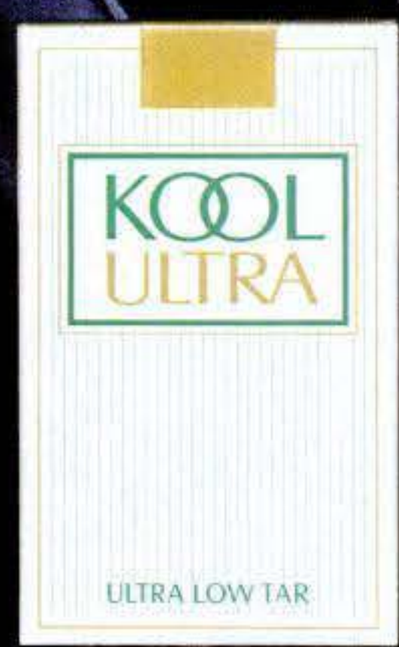

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Little benches that belong in every shop

Dual-height benches can be used at normal bench height like the Craftsman on the left, or lowered to sawhorse height like the Workmate on the right. These identical benches sell for about $90, but may be discounted.

They clamp, they support, they even fold up when you don't need them

By A. J. HAND

If the portable workbench lives up to its potential, it will be where you need it most, helping out with almost every job you tackle around the home. Otherwise, it could spend its entire life hanging on the wall.

After testing a few of these benches, I'm happy to report they live up to their potential. And a stable of new accessories makes them even more useful. In fact, if you add a few simple modifications and accessories that I developed while testing these tools, you'll find they qualify as genuine over-achievers.

The benches I checked out were:

- The Dual 29-in. Workmate by Black & Decker, plus an exact duplicate sold by Sears under the Craftsman name.
- Wen's All Bench, another 29-inch model.
- Hirsh's Foldaway Workshop, a more elaborate folding bench.
- And finally, Black & Decker's new Drop Leaf bench, smallest of the little benches.

The 29-inchers are successful examples of the compromises involved in designing a compact bench. While they are light and compact enough for easy storage and portability, they are also large enough to handle full-size jobs and heavy enough to have guts. You can take them to the job, set them up in seconds, and use them with confidence. They'll hold work of almost any shape, either between their jaws or between their swiveling plastic pegs. When the job is done, they fold up neatly and store away until next time.

Besides serving as both bench and vise, these tools also make good clamps. They're especially useful when edge-gluing two or more boards together.

Wall-mounted bench

Hirsh's Foldaway Workshop is not a *portable* bench: It's designed to be permanently mounted on your workshop or garage wall where its 20-by-36-in. bench and integral woodworking vise can swing down for business. The tool's strong suit is security: the lockable cabinet offers plenty of space for tool storage on its perfboard door pan-

Continued

el. The Foldaway Workshop can be installed with right- or left-hand door opening.

The little Drop Leaf Workmate is really too small to see much duty as a bench, and, strictly speaking, it's not really portable. Even so, I found it surprisingly useful. It really serves best as a vise, mounted at the end of a permanent workbench and level with its top. When you don't need it, it folds down out of the way. When you do, it flips up and locks into position. Despite its small size, it has the same maximum clamping capacity as its larger brothers.

Like the larger tools, this one has horizontal and vertical V-grooves cut into its jaws so it can grip pipe, tubing, and other round stock. The Drop Leaf Workmate can also be used with most of the new accessories we'll be looking at next.

All Bench's four-position legs adjust individually for variable bench height and angle. All Vise (included) can be used with chocks to hold up to 27½-in. work pieces. Price of the model 4500 bench: $80.

Hirsh's wall-mounted Foldaway Workshop has a drop-down bench that clamps work pieces with extension bars. Cabinet is 50 by 24 by seven in. closed; $190. Optional 21-in. cabinet (shown), $52.

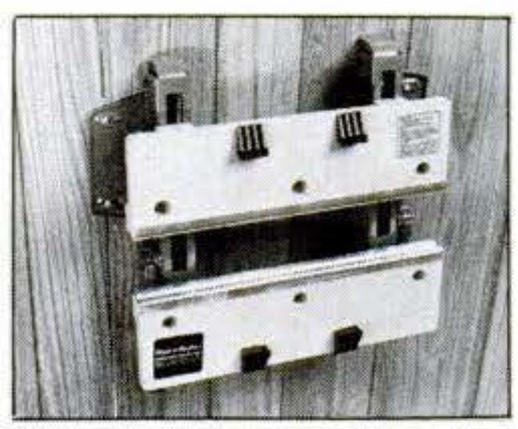
Bench accessories

Saw and miter guide. This attachment, plus the three others following, are offered by both Black & Decker and Sears, though there's no reason why they couldn't be used with the Wen and Hirsh benches. The saw and miter guide is an extruded aluminum track system that clamps between the jaws of your bench to guide your portable circular saw when making crosscuts and miters. When crosscutting it will take boards up to 17 inches wide, and when mitering at 30 degrees it will handle 7¾-inch stock. Maximum work-piece thickness is 2⅞ inches. To guide your miters the tool has a pivoting protractor arm, marked in five-degree increments from 30 to 90 degrees.

The guide has two strong suits. First, since your saw is mounted in its normal attitude—blade down—this is a safe tool, unlike setups that mount your saw under a table with the blade exposed. Second, it greatly speeds your work, especially if you are making a series of multiple cuts. You just set the protractor arm, slide your work in under the track, align your cut with the line-of-cut marker on your saw, and make your cut.

Accuracy? Good, but not perfect. The sliding track sections are a little loose, so the saw can wobble a bit from side to side. You can minimize this problem by pressing the saw toward the left edge of the track, just as if you were sliding it against a fence-type guide. The track also tends to flex up and down if you lean on the saw, and that can affect accuracy, too, until you develop the habit of using a light touch. Price for the guide is about $35.

Router and shaper guide. This is a clever router mount and work fence that—like the miter guide—clamps between the jaws of your bench. It will accept any router with a base six inches or less in diameter, and with three equally spaced mounting screws. Unlike those little shaper tables that take a router mounted bit up, this tool keeps the cutter bit completely covered. The price you pay for this safety factor is the inability to work stock any thicker than 1⅝ inches. Otherwise, the router guide is accurate, easy to adjust, and easy to use. It costs about $20.



Drop Leaf Workmate, mounted at the end of a stationary bench, will let you hold stock as long as your bench. Drop Leaf can also mount on wall studs, folds down out of the way when not in use (inset). Tool's 16-in. vise jaws open to 5¼ in.

Clamp attachments. These two fast-acting clamps fit into the peg holes in your bench top and can be used for clamping glue joints, or to hold stock that is too large to be clamped by the bench itself. (You'll need to drill ¾-inch-dia. holes in the Hirsh bench to use them.) They can handle stock up to 3¾ inches thick, pivot 360 degrees in their mounts, and are especially useful with the oversize table shown in the sketch. Price: about $15 a pair.

Drill guide. This simple rig will

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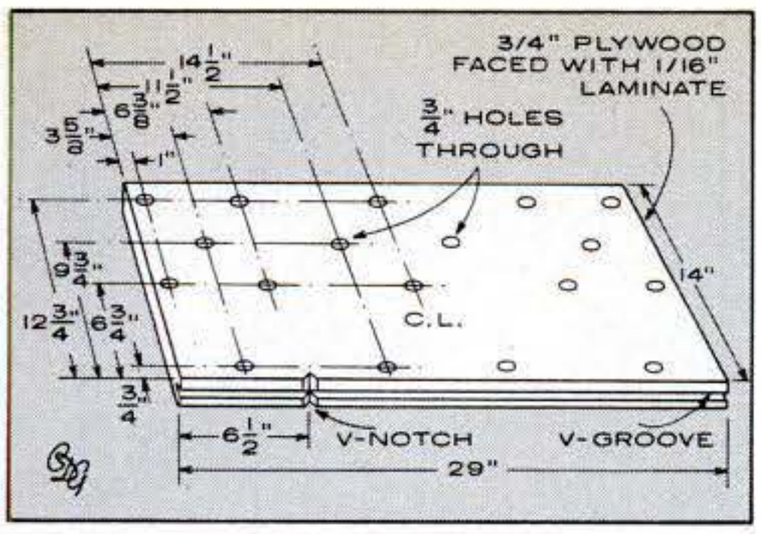
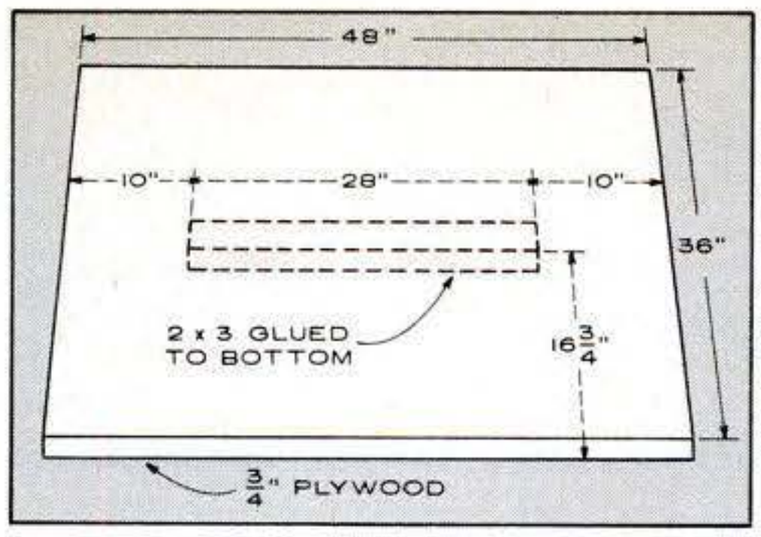
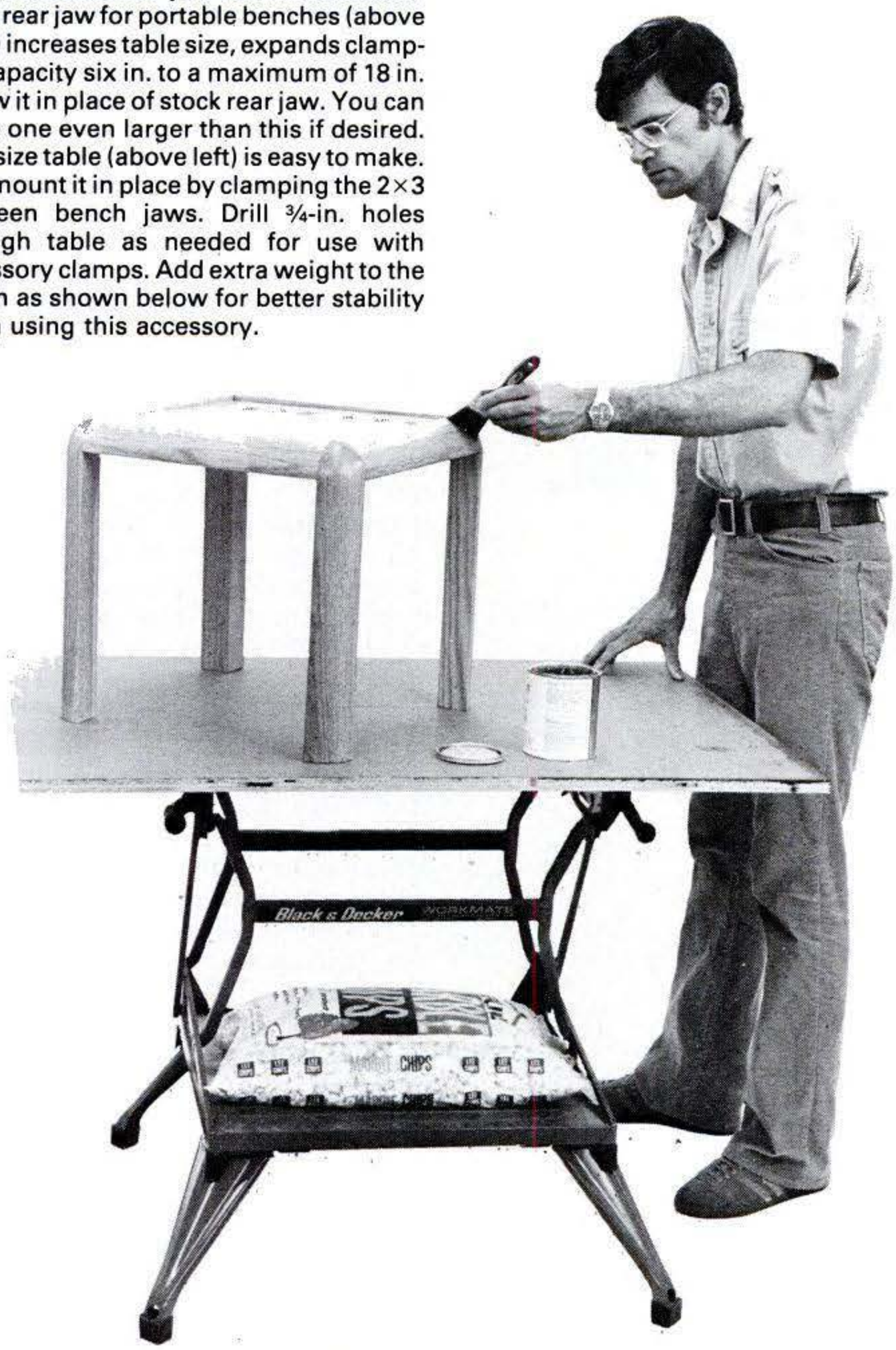




Bench accessories you can make: Extra-large rear jaw for portable benches (above right) increases table size, expands clamping capacity six in. to a maximum of 18 in. Screw it in place of stock rear jaw. You can make one even larger than this if desired. Oversize table (above left) is easy to make. You mount it in place by clamping the 2×3 between bench jaws. Drill ¾-in. holes through table as needed for use with accessory clamps. Add extra weight to the bench as shown below for better stability when using this accessory.



take just about any ¼- or ⅜-inch drill made. Clamp it in your bench and it will help guide your drill at any angle from zero to 90 degrees. It has a pair of built-in spirit levels to help you get accurate work at those two angles, plus an adjustable depth stop. Besides serving as a "mini drill press," it also makes a good drill mount when you're working with grinding and buffing wheels. Price is about $18.

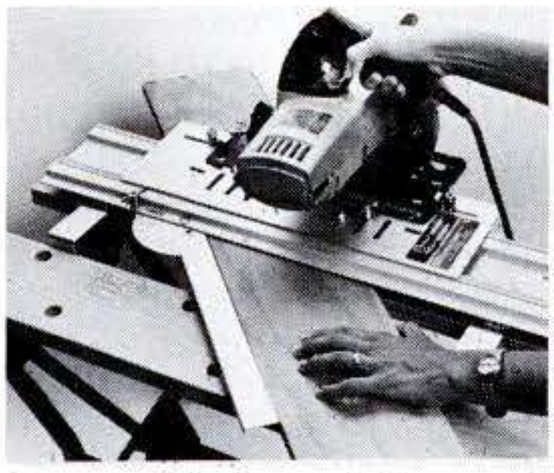
DIY improvements

In addition to these accessories, there are four other ways you can improve the portable benches:

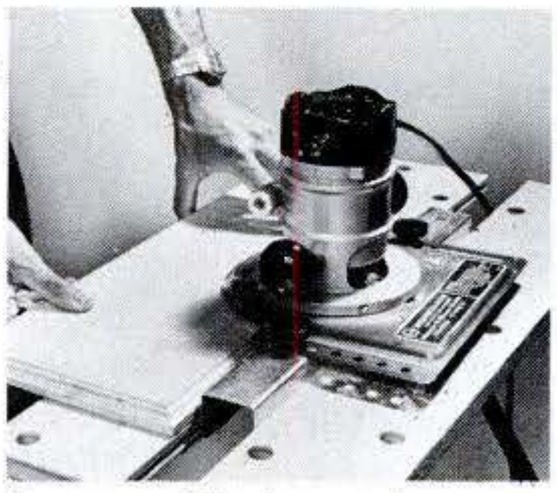
- The plastic swiveling clamp pegs are hard and can mar your work. And their faces are slick, so your work tends to pop loose now and then. You can solve both these problems by contact-cementing rubber pads cut from an inner tube to the peg faces.
- The portable benches are heavy and sturdy enough for most work, but they may skid around a bit if you're doing heavy planing or the like. Solve this by slipping a plywood shelf into the frame. On this shelf you can place a 50-pound bag of sand or gravel (see photo at left).
- When you're using the bench as a wide clamp, the maximum capacity between swivel pegs is just 12 inches. That's not enough for gluing up wide stock. You can easily extend this capacity by making an oversize rear jaw, as shown in the drawing.
- The bench top is rather small (29 by 10 inches) for some jobs. You can make an accessory top like the one shown that clamps in place between the vise jaws. Note: Since this top overhangs the legs, it can be slightly unstable. The size shown is about as large as you can go and still maintain a stable bench. It's best used with a sandbag on the lower shelf for maximum stability. PS

MANUFACTURERS' ADDRESSES

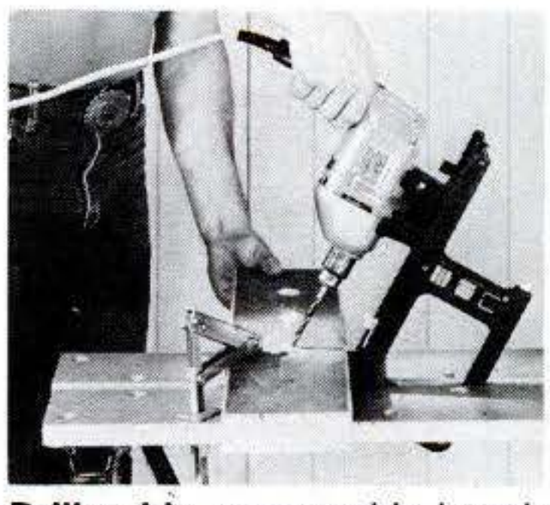
Black & Decker, 3012 Highwood Blvd., Raleigh NC 27625; **The Hirsh Co.,** 8051 Central Park Ave., Skokie IL 60076; **Sears Roebuck and Co.,** Sears Tower, Chicago IL 60684; **Wen Products, Inc.,** 5810 Northwest Hwy., Chicago IL 60631.



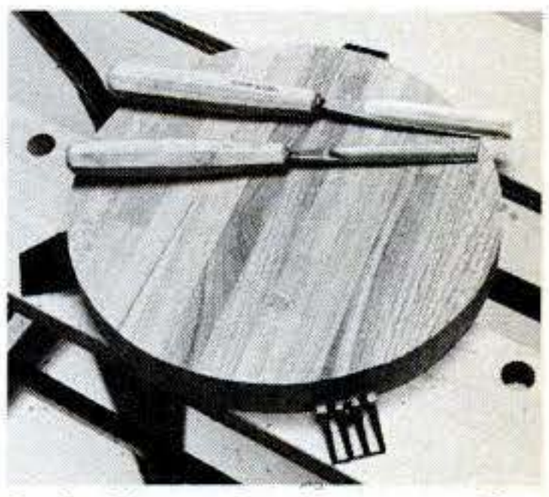
Saw guide has sliding track and pivoting protractor arm to help ensure fast, accurate cuts with your circular saw.



Router guide clamps between jaws of bench and turns your router into a shaper. Unit is sturdy, easy to use.



Drill guide, mounted in bench jaws, is used with accessory clamps, which hold work that won't fit in bench's vise.



Swiveling plastic pegs give you a grip on odd-shaped work. Pad their faces with rubber to prevent marring.

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Water-based floor finish
speeds drying and cleanup

It looks—and wears—like polyurethane. But Aqua Fabulon goes on easier and dries faster, claims its maker (Pierce and Stevens Chemical Corp., Box 1092, Buffalo, N.Y. 14240). It's also claimed to be practically odorless and to have a unique, built-in drying indicator. Because it's water based (with acrylic resins), it cleans up easily, without mess.

I tested these claims recently, applying Aqua Fabulon to a freshly sanded 18-by-25-ft. oak floor. My conclusions: The finish is not super simple to apply—if you follow the instructions as given. And it has a definite pervasive odor, though not nearly as strong as polyurethane's smell.

But the finish does dry quickly, producing a bright, clear gloss that's remained lustrous through two months of heavy wear and minimal maintenance.

Following instructions, I applied Aqua Fabulon with a large paint pad ("shake painter") fitted with a broom handle. This made for a one-step, stand-up operation—the pad slides right into corners and tight spots.

But the pad also skips unless you draw it very slowly across the floor. And I was loath at first to scrub the pad back and forth over missed spots, since the instructions said to apply the coating with the grain.

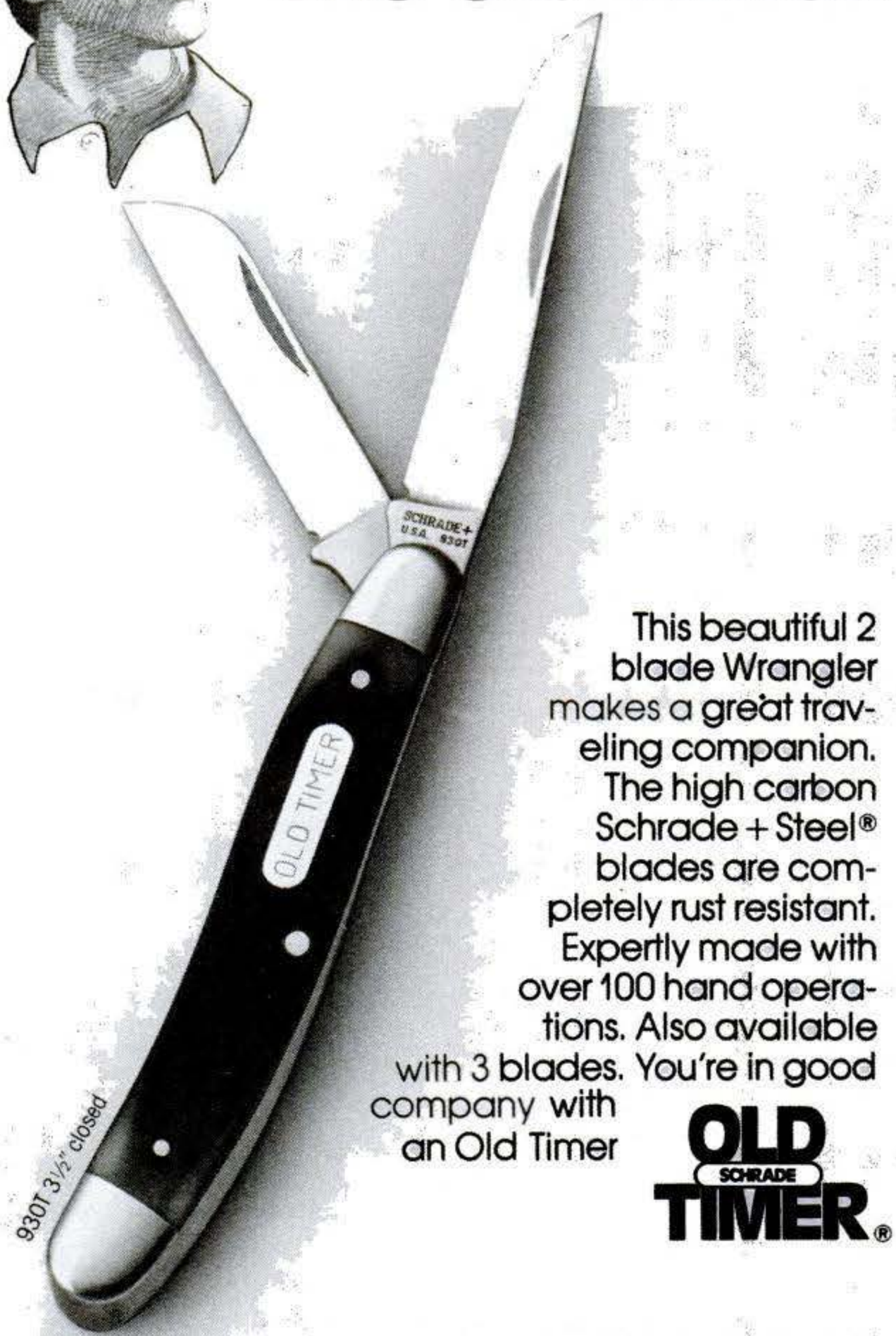
The instructions also specified that the coating should look "uniformly milky in color." This white color is the built-in drying indicator. When the finish turns clear, it's dry.

The only way I could get that white color was to lay the finish on slowly and thickly. It took me almost two hours to apply the first coat. The job was so tedious I finally stopped aiming for an even milky color and began laying down a fast, thin, almost clear coat. This coat did have a faint white cast that helped me spot the gaps before they dried.

This second floor section looks much smoother than the area where I tried to get that "uniformly milky" color. And this part dried much faster.

Though the first coat took longer to dry than the promised two hours, the second and third coats each dried in under two hours. Cleanup with plain water was as easy as promised. I waited 24 hours before moving furniture in—and have been enjoying the look of the floor ever since. Aqua Fabulon costs about $30 a gallon.—*Susan Renner-Smith*

Travel with the Old Timer.



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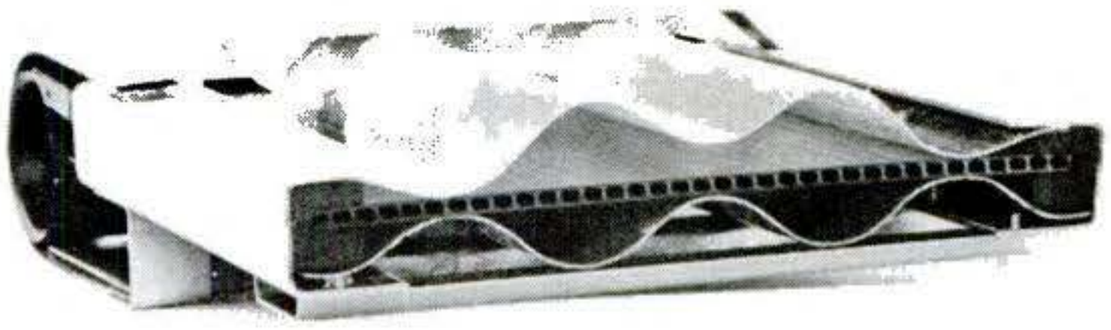
Two-tank system
for solar-heated hot water



A galvanized-steel frame houses the one-piece thermoplastic collector panel (above). It's kept in place by guides at each end.

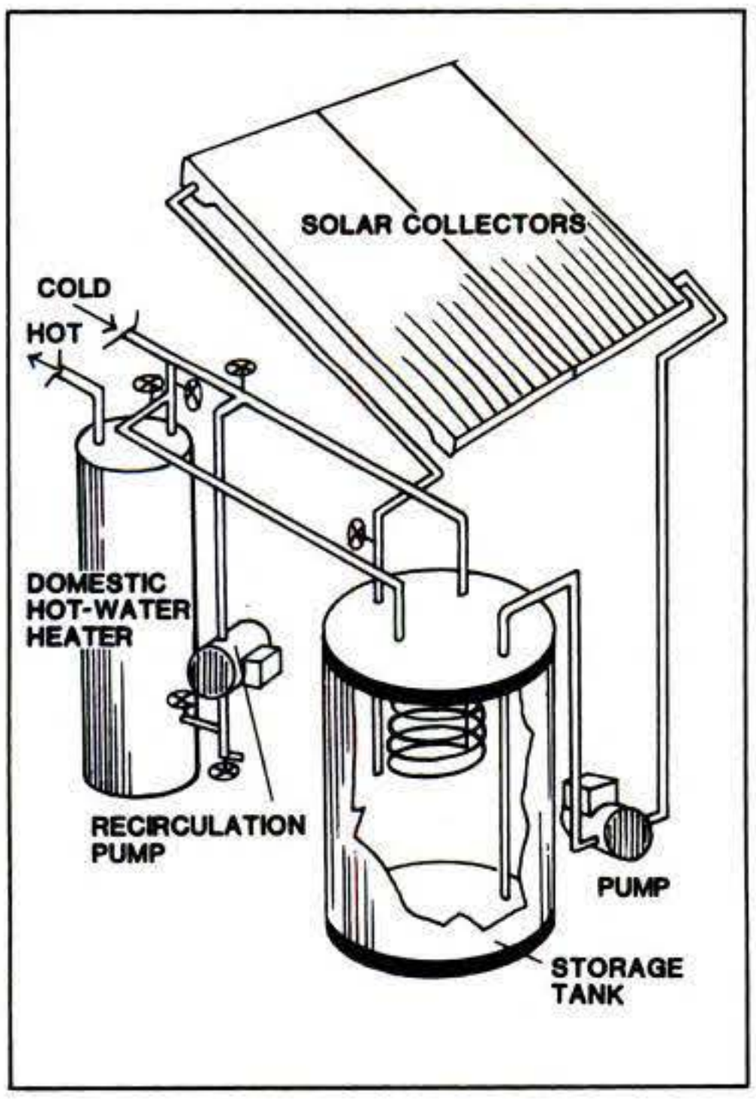
What's so different about a two-tank system? Plenty—when the second tank acts as a reservoir for stored heat energy. In most solar hot-water systems, a second tank simply stores backup hot water for domestic use. But the hot water in this 150-gallon energy-storage tank (see diagram) never flows to your taps. Instead it circulates in a closed loop between tank and solar collectors.

Meanwhile, cold water from your house main flows through the heat-exchanger coils in the large sealed tank. The now-heated water flows back to your existing water heater (no need to replace it with a special tank as in many systems).

Since cold water never mixes with solar-heated water in the sealed tank, the water doesn't stratify and lose energy as it does in other tanks. Hefty R-14 foam insulation also helps retain the heat energy. The giant tank stores so much energy, claims the maker (Sealed Air Corp., 3433 Arden Rd., Hayward, Calif. 94545), that it will heat your hot water during several days of cloudy weather. Only after a long sunless spell will your conventional water heater kick in. In the meantime it serves merely as a storage tank for domestic hot water.

The system's solar collectors are also unique, says the company. Each panel is one piece of extruded thermoplastic with oval water channels. The design permits the circulating water to contact more sun-heated surface than other collectors, it's claimed.

Sealed Air Corp. says that it has four years of in-use test results to back up its claims. It offers a five-year warranty for the $2,500 system.—*Susan Renner-Smith*



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ADVENTURES IN ALTERNATE ENERGY

A bimonthly sampling of projects PS readers have devised to conserve or replace fossil fuels

Yoked waterwheel-windmill

powers a remote ranch

All the modern comforts —almost—from a pair of home-built generators

By TED LORD

Declaring independence from the electric company may be satisfying to the soul, but my experience with independent power systems tells me that they can be justified economically only when the utility wants an arm and a leg to bring power to a remote site.

That was the problem my brother-in-law faced with his small ranch and orchard nestled in a canyon northeast of San Diego. But there was another way to go. This canyon serves as a natural venturi for winds from the coast and a useful 125-ft. drop for a 10-gallon-per-minute water source—a rare combination of natural conditions. Neither the wind nor water was adequate to run a household, but by tapping both alternate-energy sources and yoking them, I created an independent power system for less cost than the $15,000 the utility quoted for bringing in power lines.

There's still not unlimited power, of course. In fact, my brother-in-law's few appliances and constant attention to their power draw may constitute a rather Spartan life style to readers used to all the luxuries. But he does have a television, electric refrigerator, and vacuum cleaner for the first time. And he gets special pleasure from his electric razor. When one's standard of living is raised rather than lowered by this sort of system, small luxuries are a big deal.

It's a DC system, dictated by the small load and limited generating capacity. Power inverters capable of running large AC motors are costly, and they take a lot of power. We'd have had to run a backup generator almost constantly to keep the batteries charged, which would defeat the purpose of the system. Result: The lights, refrigerator, TV, and some other appliances are 12- or 24-volt DC types. A low-power inverter can handle small AC motors like the vacuum cleaner's. Any larger AC appliances, such as a washing machine, are operated off the backup propane generator.

The backup is also used for charging the system batteries on dry, windless days, but most of the load is carried by the wind generator and Pelton wheel—both of which I designed myself. The three-blade, 16-ft.-dia. wind machine drives two 12-volt alterna-

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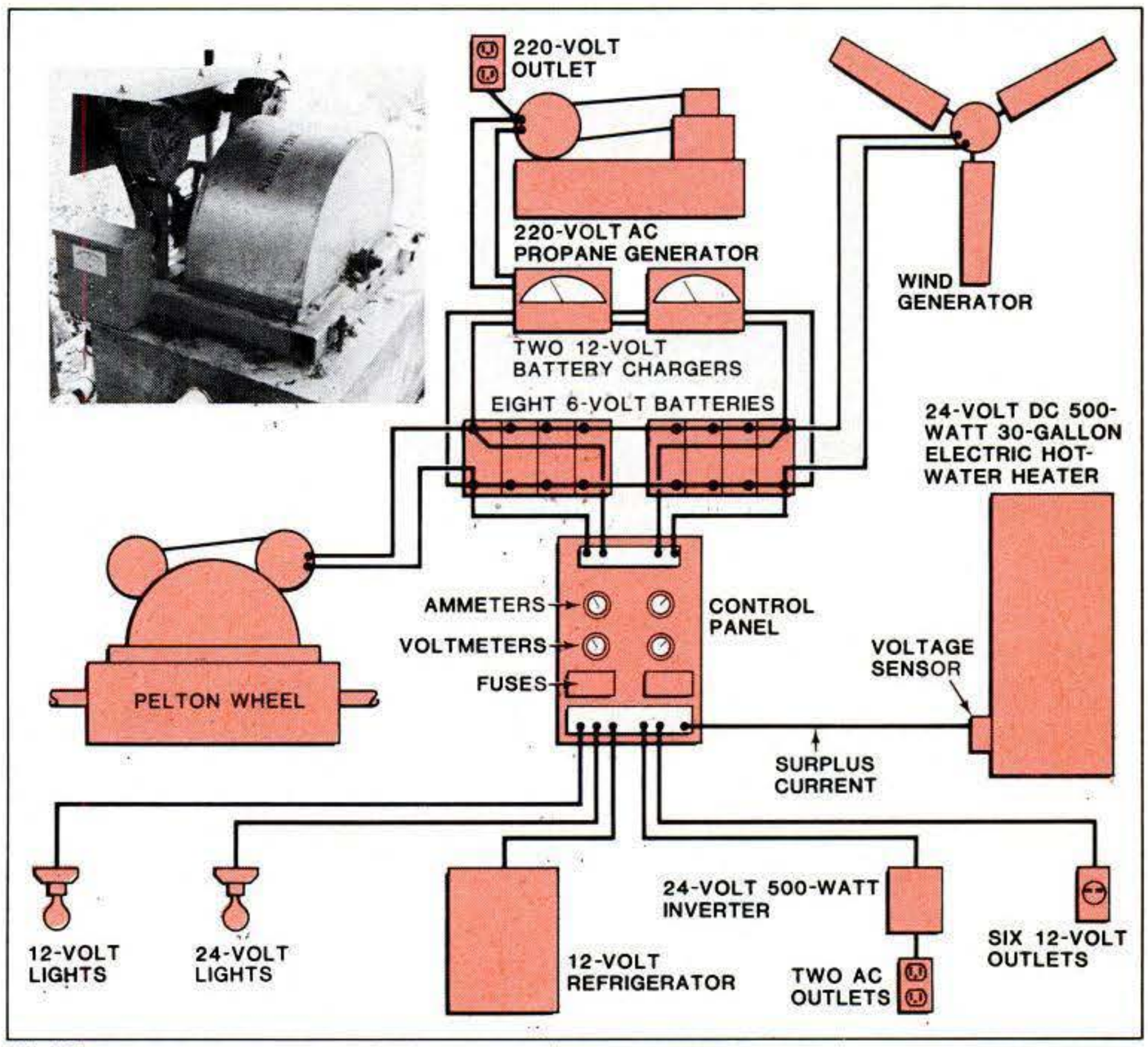

Multi-source power system is situated in a narrow canyon, with wind generator at top (author Lord is perched in tower), house and outbuildings halfway down, and Pelton wheel (inset) at bottom. Dual system is well balanced: Wind is steadier in summer, water in winter. Both generators and auxiliary supply 24-V DC to battery banks through control panel; output is from one or both banks, depending on load. Overcharge is prevented by sensor that switches input to water heater.

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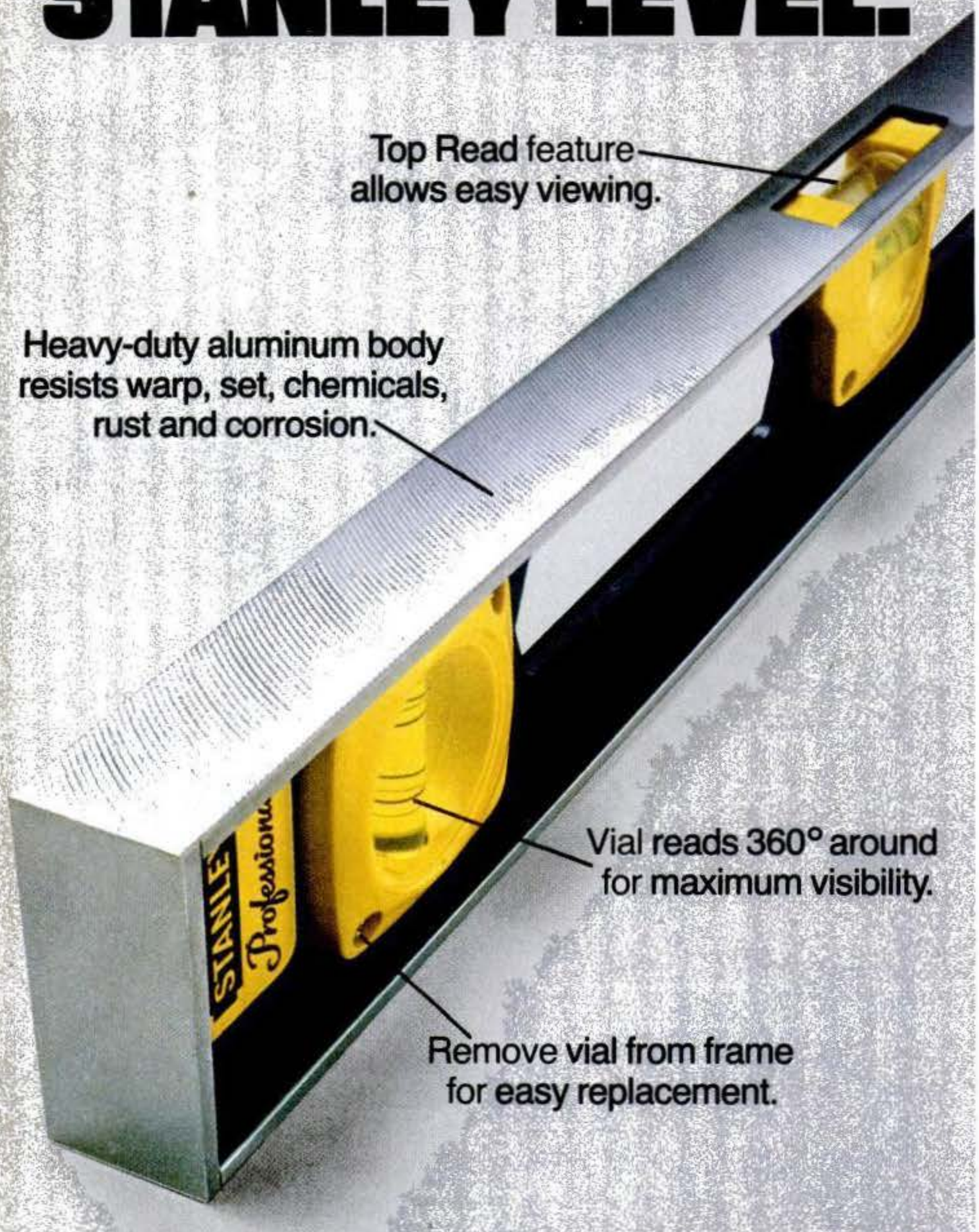

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Yoked waterwheel-windmill

[Continued]

tors, which are actuated at different speeds to make the most of available winds. The generator's maximum output, with the blades feathering at 30 mph, is two kilowatts.

I cast the 18 aluminum paddles for the Pelton wheel in a mold made from an old cast-iron paddle found on the property (an earlier owner had apparently tapped the same water source). They are bolted to a 14-in.-dia. steel wheel, which is driven by water (from a reservoir at the top of the hill) falling through 250 feet of pipe and a brass fire nozzle. The system is controlled by an electric valve, which is actuated either manually or automatically when the reservoir is full. After a time delay to allow the wheel to get up to speed, a pair of 12-volt alternators comes on. The Pelton wheel's output is about 300 watts.

Both generators feed a double bank of eight 220-amp-hour golf-cart batteries hooked in series/parallel to provide either 12- or 24-volt output. When there is an excess of electricity, a voltage sensor switches the load to a standard electric water heater (house water is otherwise heated by gas) to prevent overcharging. This eliminates the need for more cells that would be undercharged most of the time.

In practice, my brother-in-law keeps a close watch on the batteries' state of charge, arranging his life around power availability. The system works well because he is interested and involved in it. By contrast, I have since designed a system using solar voltaic cells for a rental property in Arizona. In that case, everything had to be completely automatic and fail-safe.

Both systems demonstrate the economic sense of independent power systems at remote home sites. To further pursue application of such systems, I recently moved my company (Hooper-in-Longjohns, Ltd., Box 61, Silver City, Nev. 89428) to Nevada, a state whose widely spaced homes and available wind, sun, water, and geothermal steam make it ripe for this kind of development.

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Every other month, we present a project developed by a PS reader and pay the inventor $200. To enter, send us black-and-white glossies (one photo should show you demonstrating the device), plus a description and sketches. Include your name, address, and social-security number. No material can be returned unless you enclose a stamped, self-addressed envelope.

Since space won't permit us to present projects in detail, we'll expect inventors to answer any reasonable query from readers, if it's accompanied by a stamped envelope.

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MAGNAVISION

High-altitude simulator

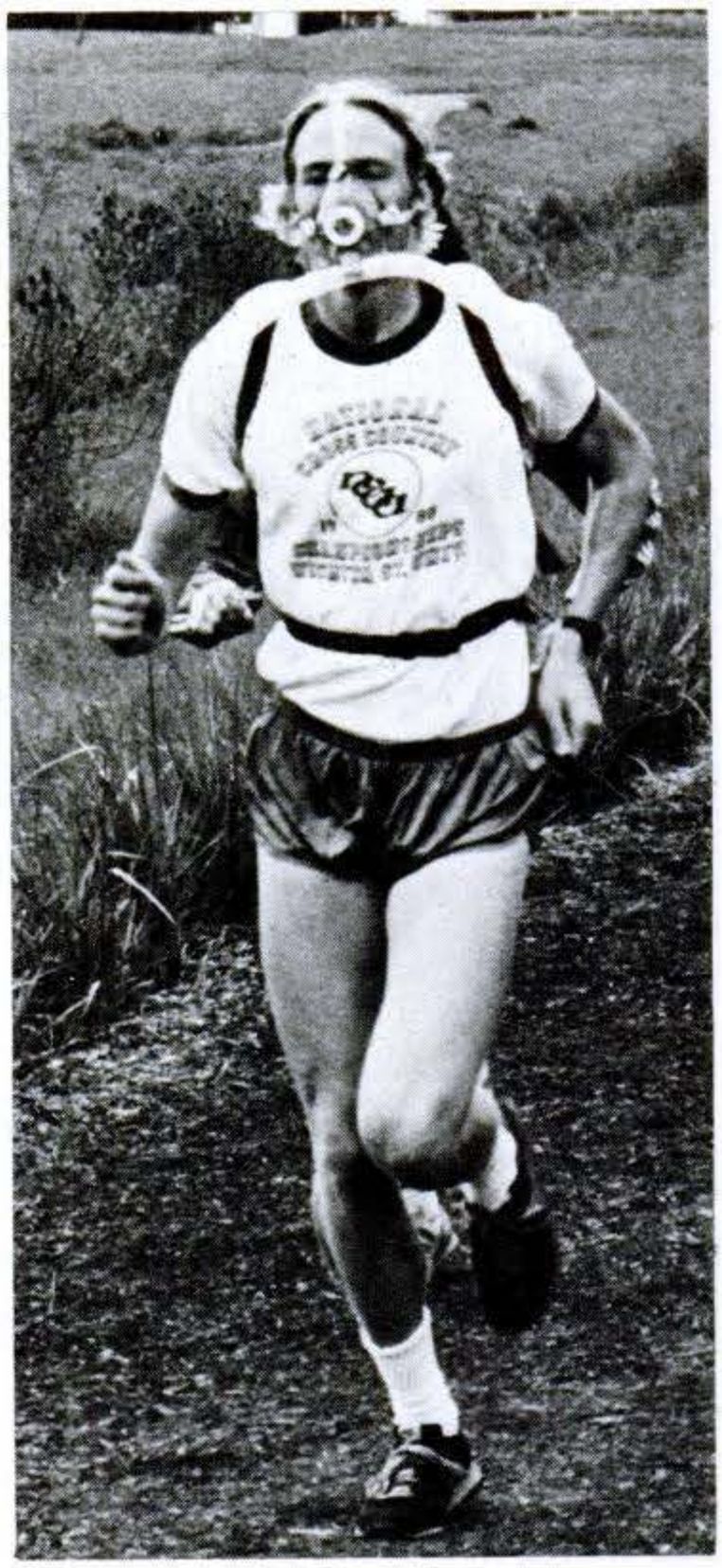
puts out rarefied air for sea-level training

Would you like to improve your cardiovascular fitness? The PO_2 Aerobic Exerciser should help. The device mixes recycled air with fresh to simulate the rarefied mix breathed at 7,500 feet.

How can a portable device simulate mountaintop air? The air exhaled by the runner (photo) flows through two backpack canisters that absorb carbon dioxide. The cleansed air, with an oxygen content of 16 percent, is then mixed with outside air (21 percent oxygen) that the runner gulps through the mouthpiece. The mix simulates the lower partial pressure of oxygen (PO_2) at high altitudes.

This thin air puts stress on cardiovascular and respiratory systems, increasing endurance faster than ordinary training, says InspirAir Corp. (2630 Townsgate Rd., Westlake, Calif. 91361).—*S. Renner-Smith*

With backpack air filters, the PO_2 exerciser weighs four pounds. When exhausted, the carbon dioxide-absorbing granules change color to show replacement is needed. The $219 device will also help skiers and cyclists build endurance.



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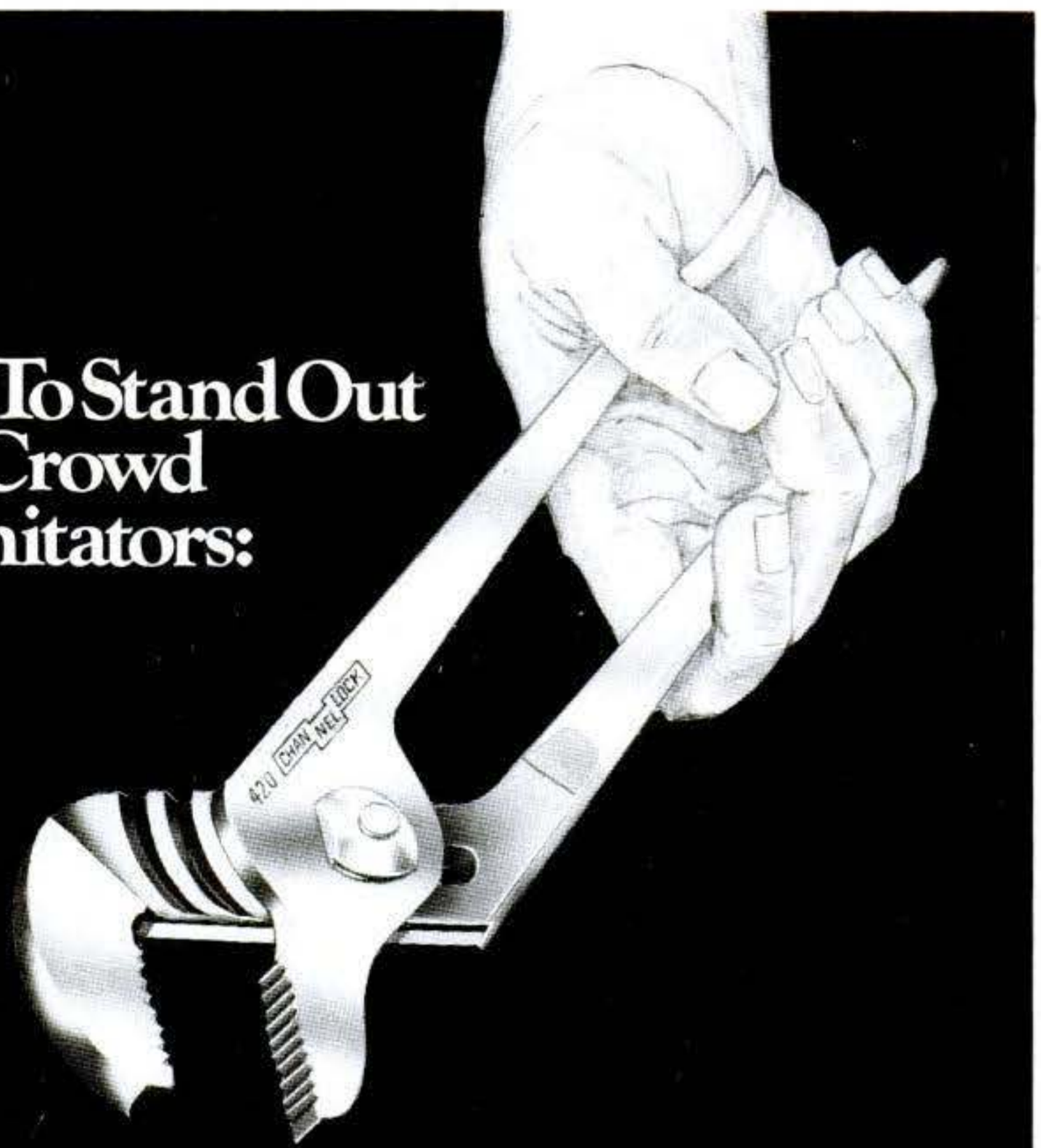

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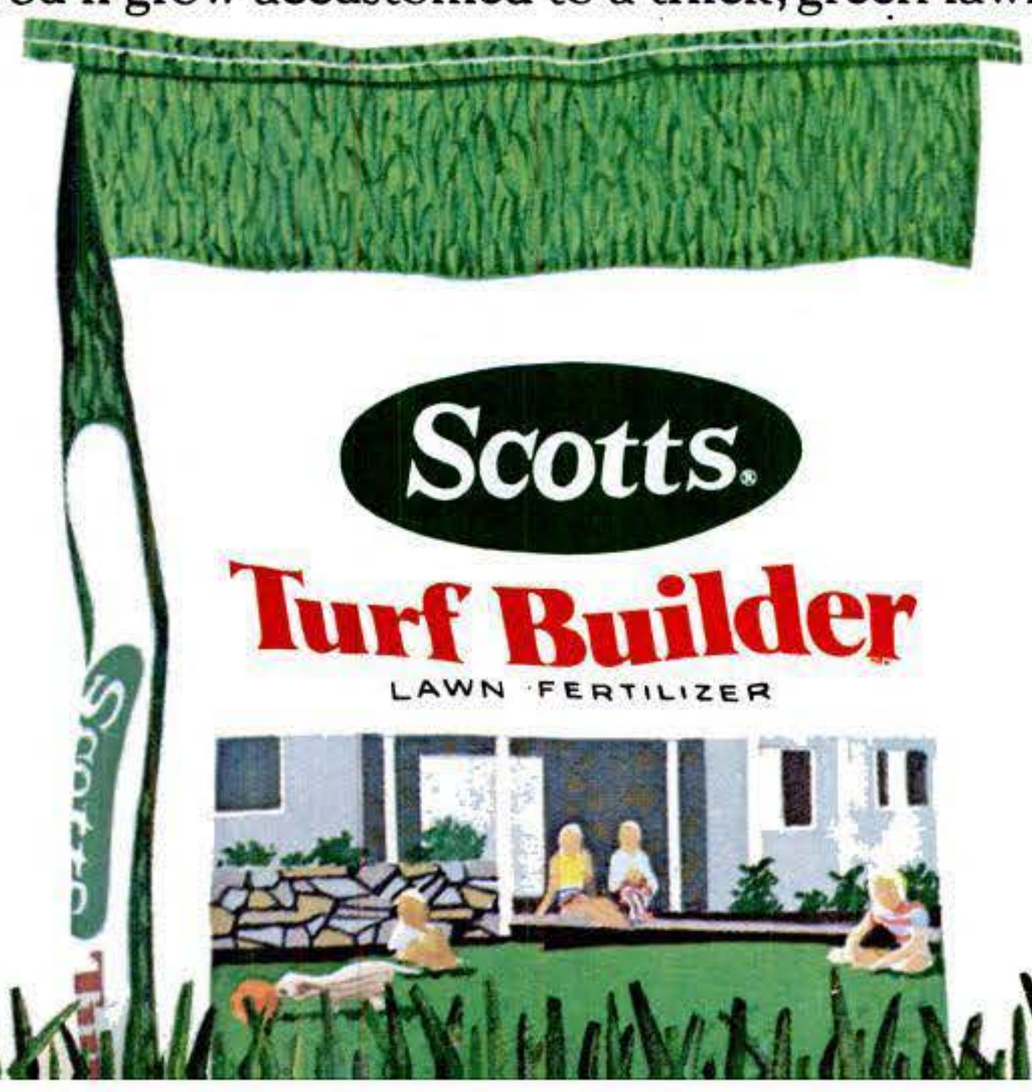

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The 8K Extended BASIC chip used in the ZX81 is available as a plug-in replacement for your ZX80 for only $39.95, plus shipping and handling—complete with new keyboard overlay and the ZX81 manual.

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Wonder windows
— four new-technology glazings that save energy

Two let in more sun; two keep in more heat

By V. ELAINE SMAY

Windows are rather like the little girl with the little curl in the middle of her forehead: When they are good, they are very, very good—they let in the sun to illuminate the interior and warm your house. They can provide a nice view, too.

But when they are bad, they are horrid—probably at their most mischievous on a cold winter night, when they may let out much more heat than they collected during the day. They're not so nice either when it's 99 degrees and the sun is streaming in.

Multiple glazing improves their thermal behavior. But a double-glazed window still transfers heat six times as readily as a moderately well-insulated (R-11) wall. And even a triple-glazed window passes heat four times as readily. "About five percent of our national energy consumption goes to offset heat loss through windows," says Stephen E. Selkowitz, who heads a Department of Energy-sponsored program at Lawrence Berkeley Laboratory aimed at improving windows' energy efficiency. "That's about 1.7 million barrels of oil a day." And it may account for 12 percent of your household energy use.

No one has yet come up with a window that's a real Pollyanna, giving all possible benefits all the time. But four new products (three available now and one coming soon) do offer significant improvement—and by opposite means. Two use an ingenious transparent coating that reflects heat. One of these is a coated glass, called Low-E glass, made by Airco Temescal of Berkeley, Calif., and Guardian Ind. of Carleton, Mich. The other is a coated plastic film, Heat Mirror, made by the Southwall Corp. in Palo Alto, Calif.

Transparent-plastic film, SunGain from 3M, lets in more solar heat and light than conventional window glass. One or two layers of the film are put in the air space between two panes of glass to make triple- and quadruple-glazed windows.

A third new product, made by the 3M Co., is also a thin plastic film. This one, called SunGain, lets in more solar heat than glass. The fourth product, glass with a reduced iron content, does the same. Low-iron glass, Solakleer, is made by General Glass International, New Rochelle, N.Y.

All could help make energy winners of more windows and make passive-solar design easier to live with by eliminating the expense and nuisance of movable insulation to cover glass.

The coating on Heat Mirror film and Low-E glass is similar to what has been used on airplane windshields since World War II. It is electrically conductive, and sending a current through it de-ices the windshield. But such glass is costly and is produced only in small quantities.

"In 1969," reports Day Chahroudi, a physicist then with Zomeworks, "I learned of the windshield technology and decided it could be adapted for glazing systems to create a transparent insulation." In 1974, Chahroudi joined the architecture department of the Massachusetts Institute of Technology. There he, John Brookes, and Sean Wellesley-Miller developed the technology. The Southwall Corp. was later formed by the group.

Airco Temescal makes vacuum-

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deposition machinery for the semiconductor industry and got interested in the coating because it is applied with similar machines.

Southwall's Heat Mirror, a two-mil polyester film, is used in triple-glazed windows with one layer of film and two panes of glass (see diagram). A number of window makers now sell Heat Mirror windows and more should be soon. Low-E glass is used in double-glazed units. (E stands for emissivity, a measure of a material's infrared-reflectance characteristics.) Guardian Ind. expects to have Low-E windows available by year's end.

The coating on these glazings reflects long-wave infrared radiation (radiant heat), the kind emitted by room-temperature objects and people (see box). Unlike solar-control films ["Window Insulator," PS, June '78], it transmits most of the solar spectrum. Solar-control films darken the window from the inside and give it a mirrorlike look from the outside. With Heat Mirror film, the window isn't visibly different from triple-glass windows. Heat Mirror lets through 72 percent of the solar spectrum and 88 percent of visible light. Low-E glass has a slight bluish cast from the outside, but looks clear from inside. It transmits 71 percent of visible light and 56 percent of the solar spectrum.

Windows with a Heat Mirror film or Low-E glass will have the same convective and conductive heat loss as do those with equal panes of conventional glass and equal air spaces. But they reduce heat loss through radiation. That can amount to ½ to ⅔ of the total heat loss. Glass absorbs radiant heat and reradiates it in all directions—outside and inside. These coatings reflect 85 percent of the radiant heat, so most stays in the room.

The net effect can be seen by comparing U-values (a measure of heat flow in Btu/hour/square foot/degree F). The lower the U-value, the less readily the material transfers heat.

A single-glazed window with standard glass has a winter U-value of 1.13. A double-glazed window with a ½-in. air space is 0.56. A triple-glass unit with two ½-in. air spaces is 0.34. A window with one Heat Mirror film, two panes of glass, and two ½-in. air spaces has a U-value of 0.23. "That's 32 percent lower than triple glass," says Alexander Tennant, Southwall's vice-president for marketing, "and you reduce the weight 33 percent."

Airco-Guardian's Low-E glass in a double window has a U-value of 0.33, about equal to triple glass but with only the bulk and weight of double.

The energy advantage of such windows should be even greater than these numbers suggest. Window surfaces will be warmer, so you won't radiate as much body heat to them and drafts will be reduced. And you can raise humidity without getting condensate on the windows. These factors make you feel warmer at lower thermostat settings. "The net benefit can be a three to five percent additional improvement," says Tennant. In summer, you'd have less heat gain.

In a climate where heating costs more than cooling, it is not just heat loss that counts, however; it's the net energy transfer—the amount of solar heat the window lets in minus the room heat it lets out. Heat Mirror film and Low-E glass let in somewhat less solar heat than conventional window glass. High-transmission glazings—3M's SunGain and General Glass International's Solakleer—let in more. SunGain transmits 93 to 96 percent of the incident solar energy and Solakleer transmits 90 percent. Standard glass transmits 84 percent.

SunGain is a polyester film with a coating that reduces surface reflectance (see box). Weather Shield, a window maker in Medford, Wis., is using SunGain film as inner glazing

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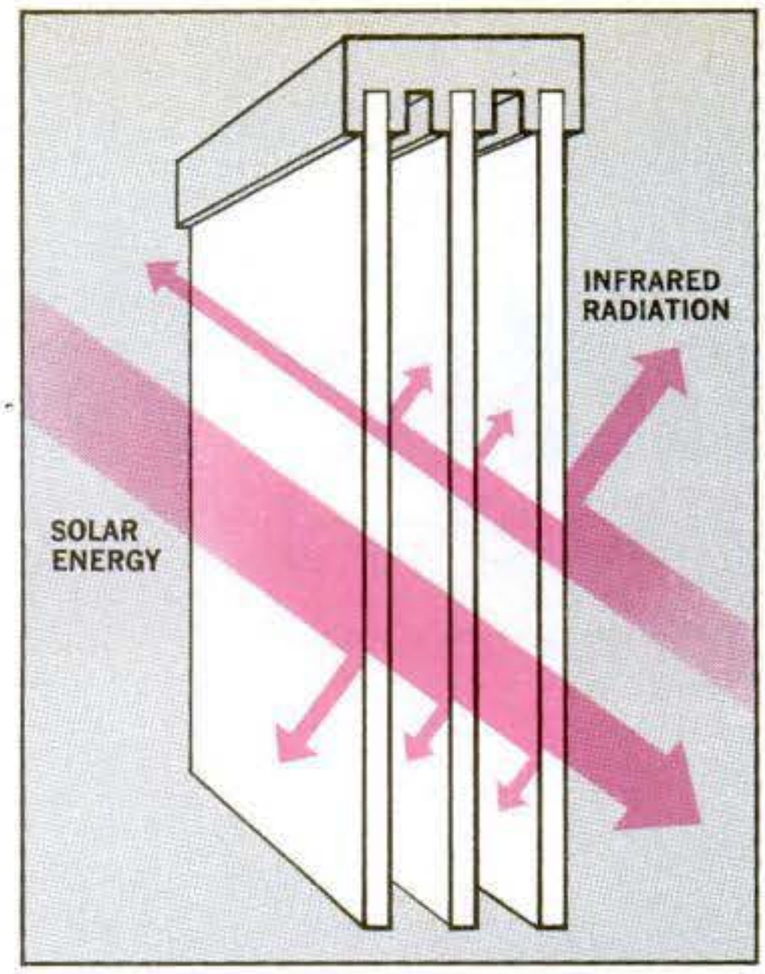
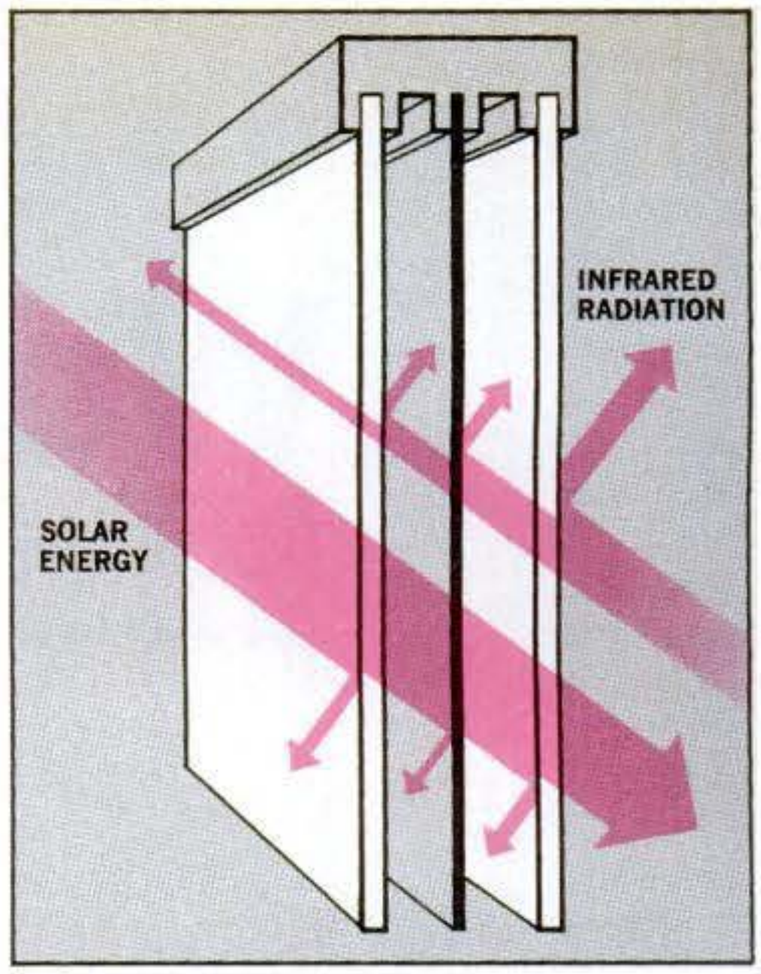
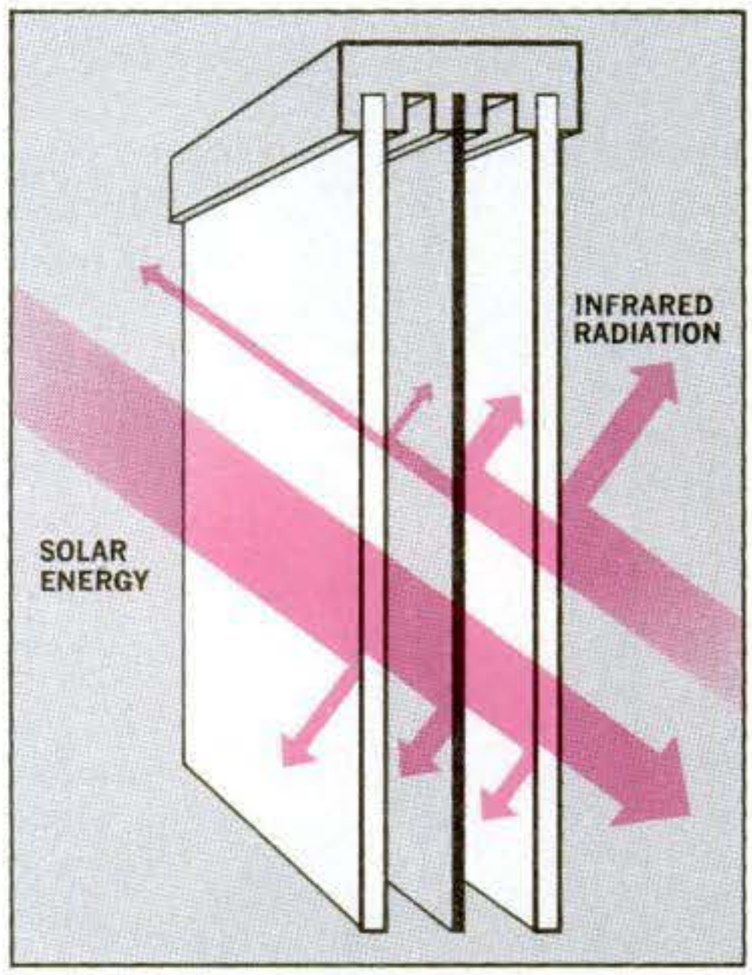


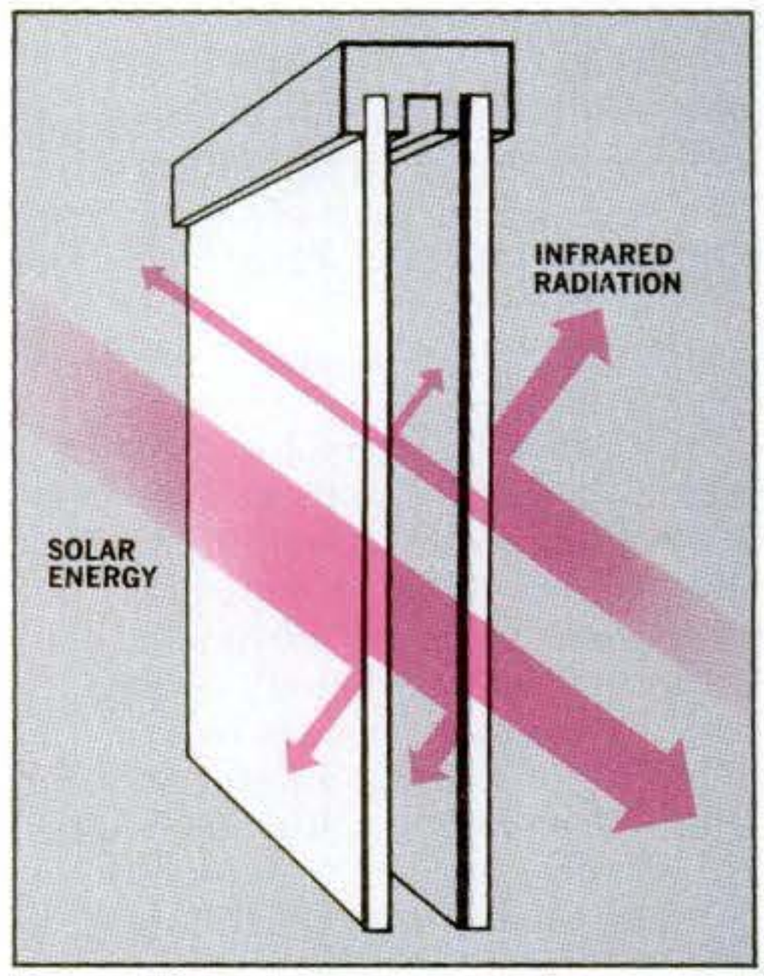
Triple-glass window transmits most of the incident solar radiation, but each pane reflects and absorbs some. Infrared radiation from room objects is absorbed by each pane and reradiated both ways.



SunGain film, the inner glazing here, transmits more solar radiation than glass. It does not block infrared transfer quite so well, but its thinness allows a larger air gap so the total U-value is equal.



Heat Mirror film, the inner glazing here, admits less solar radiation than glass. But it saves heat better by reflecting back most of the infrared radiation emitted by the interior pane of glass.



Low-E glass transmits less solar energy than Heat Mirror film. But the window has fewer panes to reflect and absorb it, so total solar gain is a bit better. Low-E's IR reflectance equals Heat Mirror's.

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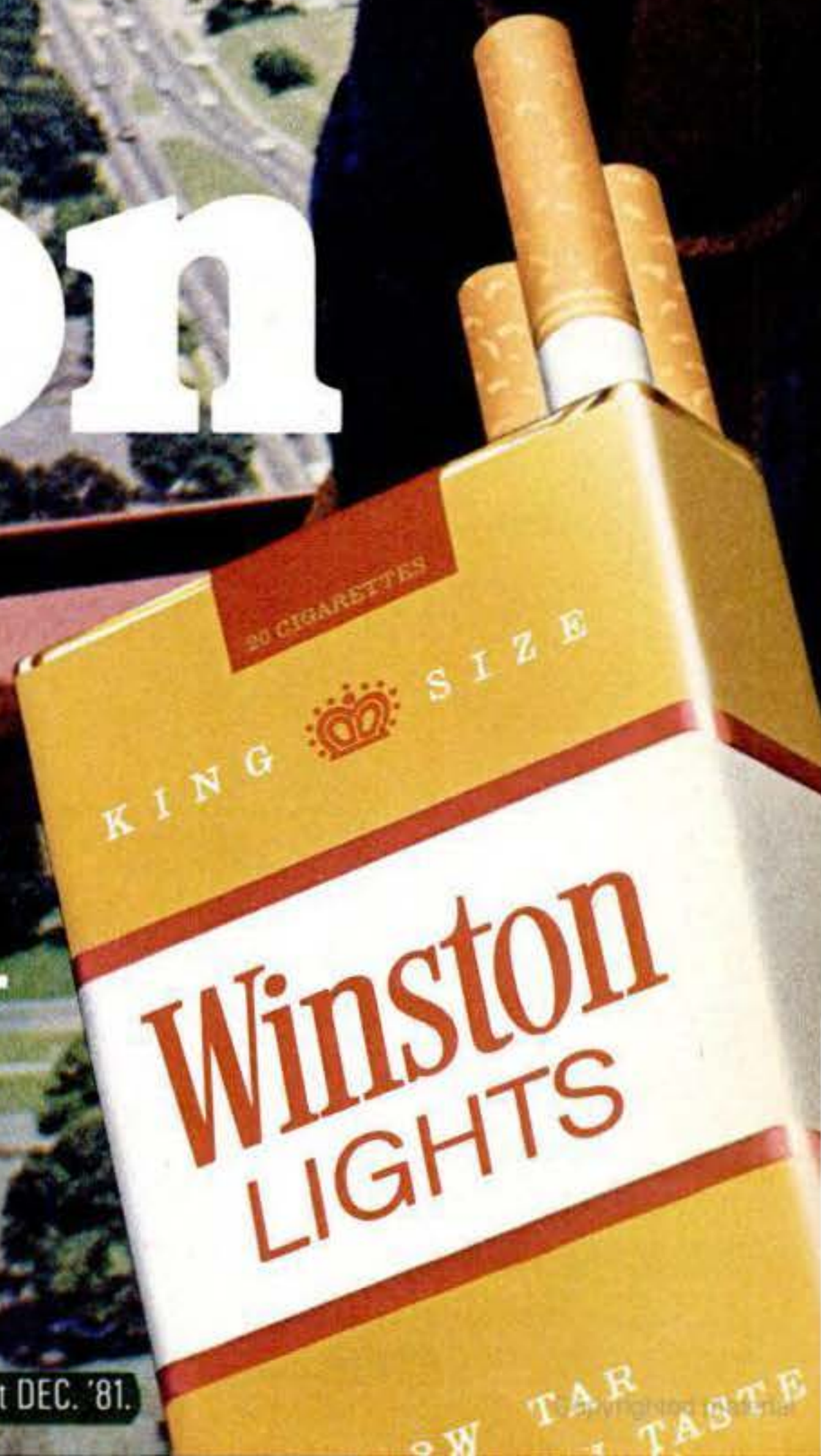

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Wonder windows

[*Continued*]

between two panes of glass (see diagram). The company offers triple- and quadruple-glazed windows, doors, and patio doors. The quad-glazed units have a U-value of 0.26—about the same as triple-glazed windows with one pane of Heat Mirror film and with a comparable benefit from warm window surfaces.

Low-iron glass improves solar transmission by reducing its absorption within the glass, which is caused by impurities in the glass, mainly iron

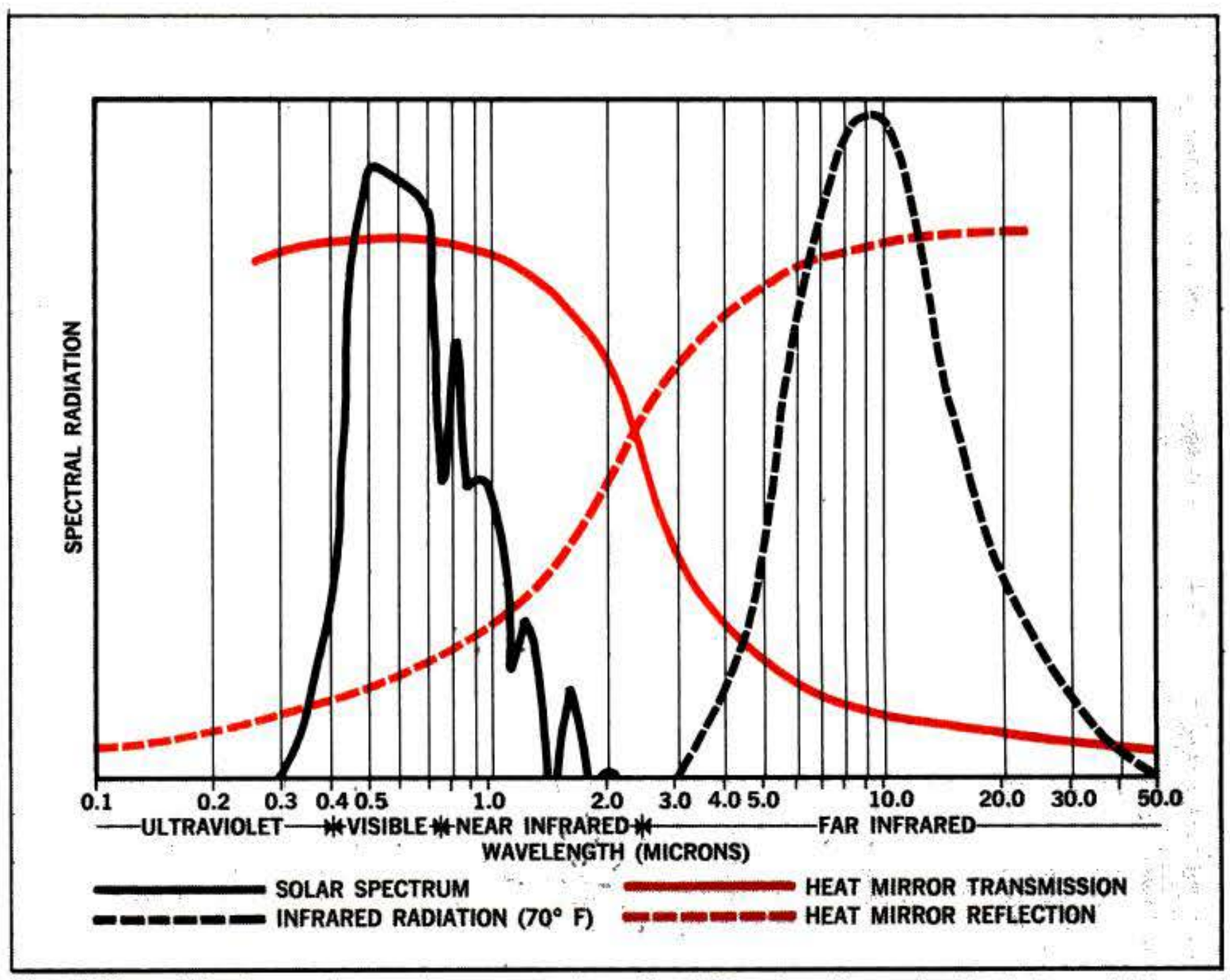
Continued

How the coatings work

Heat Mirror film and Low-E glass are coated with a three-layer sandwich only a few hundred atoms thick. The center layer is a conductive metal—gold, silver, copper, or aluminum. The metal layer is between two layers of a metal oxide, a dielectric or insulator. The metal layer reflects long-wave infrared energy as the free electrons in the metal (those unattached to an atom) interact with the electric field in the IR. It also reflects some of the desirable solar radiation. "But the higher the frequency of the radiation, the less efficient the reflection," explains Dr. Stephen Meyer, a physicist with Southwall, "so even if the metal layer were used alone, about 50 to 60 percent of the solar spectrum would get through." But the two metal oxide layers improve the solar transmission to around 72 percent. "As the higher-frequency wavelengths hit the metal, there's a 90-degree phase jump," Meyer explains. "That's what causes most of the reflection." The metal oxide layers are engineered to cancel that jump, and thus let the solar radiation pass through the metal. "It's similar to impedance matching in electrical transmission," he adds, "where you use a transmission line to transform an impedance and bring the voltage and current in phase with each other."

The coating on 3M's SunGain film is an ultrathin layer of a transparent metal oxide. Aluminum, magnesium, or zinc oxides can be used.

As light passing through one transparent medium (air, for example) hits another with a different index of refraction (glass or polyester film), part of it is reflected. The greater the difference in the two indices of refraction, the greater the reflection. SunGain film reduces that reflection with a surface microstructure. "We call it a graded index of refraction," says George Ruth, 3M's project leader for SunGain's development. The surface, magnified 100,000 times, looks rather like velvet fabric—tiny needles give it a "nap." These needles, roughly cone-shaped, gradually increase the metal oxide's effective index of refraction from tip to base. Thus it acts as a transition between the air and the polyester film.



Heat Mirror film is engineered to transmit solar radiation in the visible and near-infrared portion of the spectrum (solid red line). But it reflects the far infrared (dotted red line), the long-wave radiation emitted by room-temperature objects.

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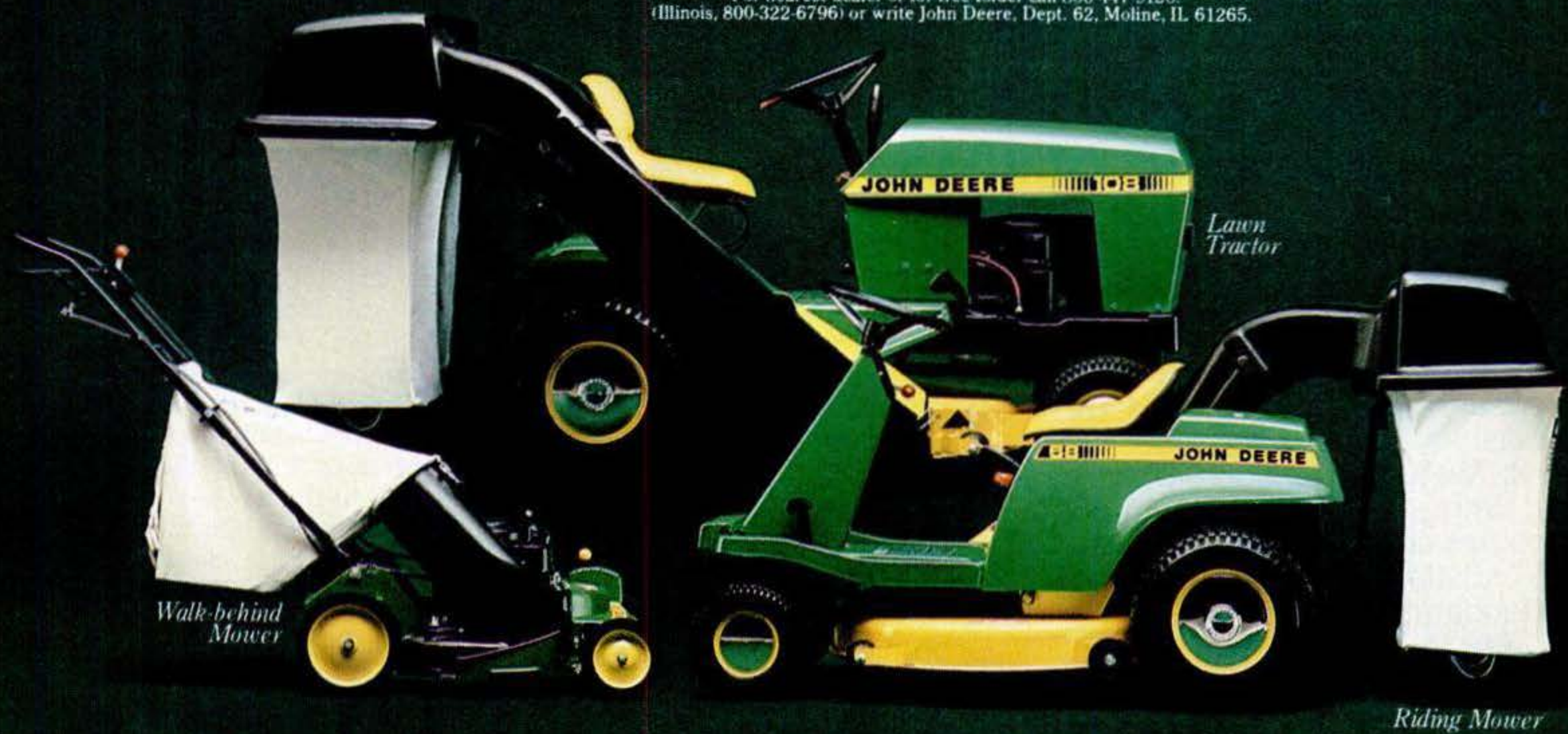

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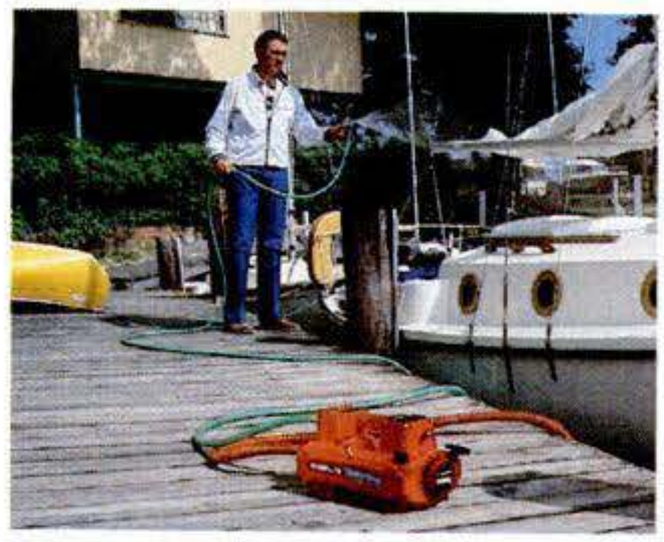

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oxides. Solakleer glass has fewer impurities. It is sold to window manufacturers who put it in single-, double-, and triple-glazed windows.

Adding a layer of Solakleer glass or SunGain film lowers a window's U-value as much as adding a pane of conventional glass. But since you don't sacrifice as much solar heat, the net energy gain is improved. The 3M Co. calculated the net energy gain for south-facing windows in a moderate climate (Indianapolis, Ind.), comparing quadruple-glazed SunGain windows with standard double glass and night insulation (R-5) in place 14 hours a day. The SunGain windows came out slightly better.

But all these new technologies cost more than standard windows. Airco Temescal expects double-glazed windows with one pane of Low-E glass to cost 12 to 22 percent more than conventional double-glass windows, but a little less than triple glass. Hurd Millwork, Medford, Wis., will sell wood-frame triple-glazed windows with one pane of Heat Mirror film for seven to 10 percent more than triple-glass windows. Weather Shield's wood units range from eight to 12 percent more for triple glazing with SunGain film than for triple glass; quad glazing (two panes of SunGain) is about 17 percent more than triple-glass units. Solakleer costs about 20 to 30 percent more than standard window glass.

Would you soon make up in energy savings for these higher initial costs? "In the long run," says Selkowitz, "I think all of these products will be cost-effective, but the specifics depend on fuel prices, climate, the orientation of your windows, and their cost."

Which type would be best for your windows? "In general," Selkowitz explains, "the colder and more overcast the climate, the more important the U-value and the less important the solar transmission. In a climate that's sunny but needs significant heat, you should pay attention to solar transmission. Furthermore, on the north side of the house a low U-value is more important. On the south, you might want high solar transmission."

Selkowitz offers this additional advice: "The biggest concern about the coatings is how well they will last." All have been extensively tested and seem to hold up very well as long as the seal around the window holds. "But we'll only know for sure," he points out, "after they've been in the field 10 or 15 years."

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Instant building folds flat for moving

A 40-foot-wide building of just about any length can be put up in a hurry with these prefabricated hinged assemblies from a British firm. The assemblies fold flat for storage and transport. At the building site, a crane hoists them upright and robust tie rods are bolted just under the apex of the roof to hold them in position. Any number of sections can be combined to form a building of the length you want.

When the sections are up, gables are added and standard end walls put in place. The end walls have doors; transparent panels in the roof provide light for the interior.

Intended for temporary use, these instant buildings can be quickly dismantled for reuse. They're made by George Cohen Machinery, Ltd., London.—*David Scott*

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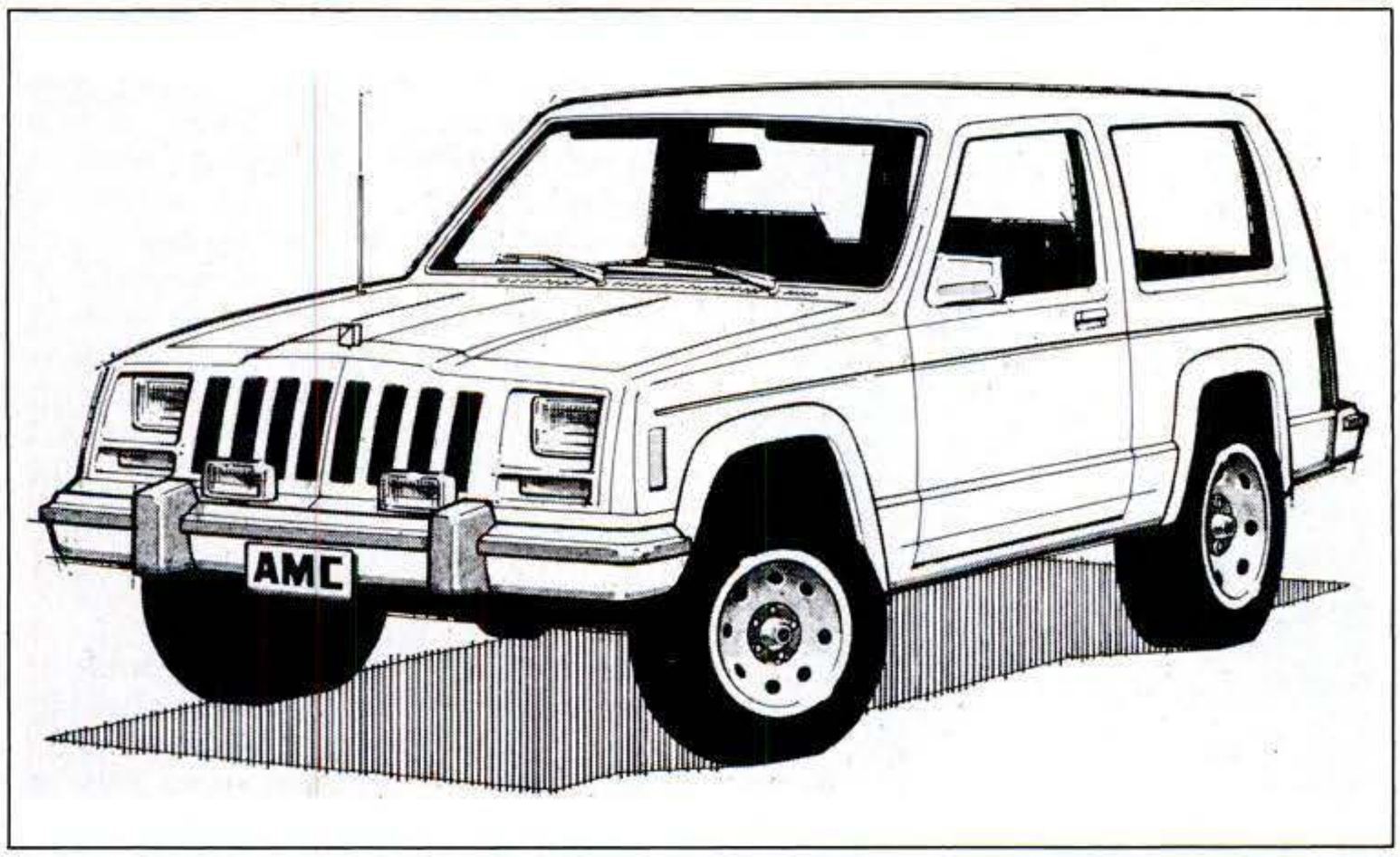
DETROIT REPORT

By JIM DUNNE



New XJ from Jeep

AMC has a surprise: It's a completely new Jeep line for 1983, smaller and lighter, with updated styling and a big improvement in fuel economy (drawing, top). The base engine will be a 2.5-liter four-cylinder engine supplied by Pontiac, with a Chevy 2.8-liter V6 optional. AMC predicts 25 mpg in city driving with the four, 20 mpg with the V6. That will make the new Jeep an economy leader among four-wheel-drive utility vehicles.

Code-lettered XJ, the new line will fit between the Wagoneer and CJ Jeep lines. But don't be surprised to find the XJ replacing the Wagoneer/Cherokee in a couple of years. AMC wants to see how buyers respond to XJ before making a final decision on Wagoneer.

The XJ is 21 in. shorter than the Wagoneer and weighs only 2,750 pounds. The chassis is a unit-body type, a first for Jeeps. "We made it smaller, but you won't get a pantywaist," is the way AMC vice-president Dale Dawkins describes the vehicle. "We will maintain superiority in size over Ford and GM 4WD products that are coming next year," adds Dawkins. AMC hopes the 4WD market, which it describes as a "disaster" right now, will rebound because of more-fuel-efficient vehicles such as the XJ.

Mini-Blazer is different

Body construction of Chevrolet's 1983 four-wheel-drive utility vehicle—dubbed "mini-Blazer" by the press—will be different from that of current Chevys (photo above). While the cab and front end are taken directly from the S-10 pickup, the rear will feature a number of departures. The roof will be a permanent structure, not bolted on and removable as on current models. And while the rear opening features a top-hinged window, the lower half of the body at the rear is fixed in place. What that adds up to is a more rigid body,

Continued

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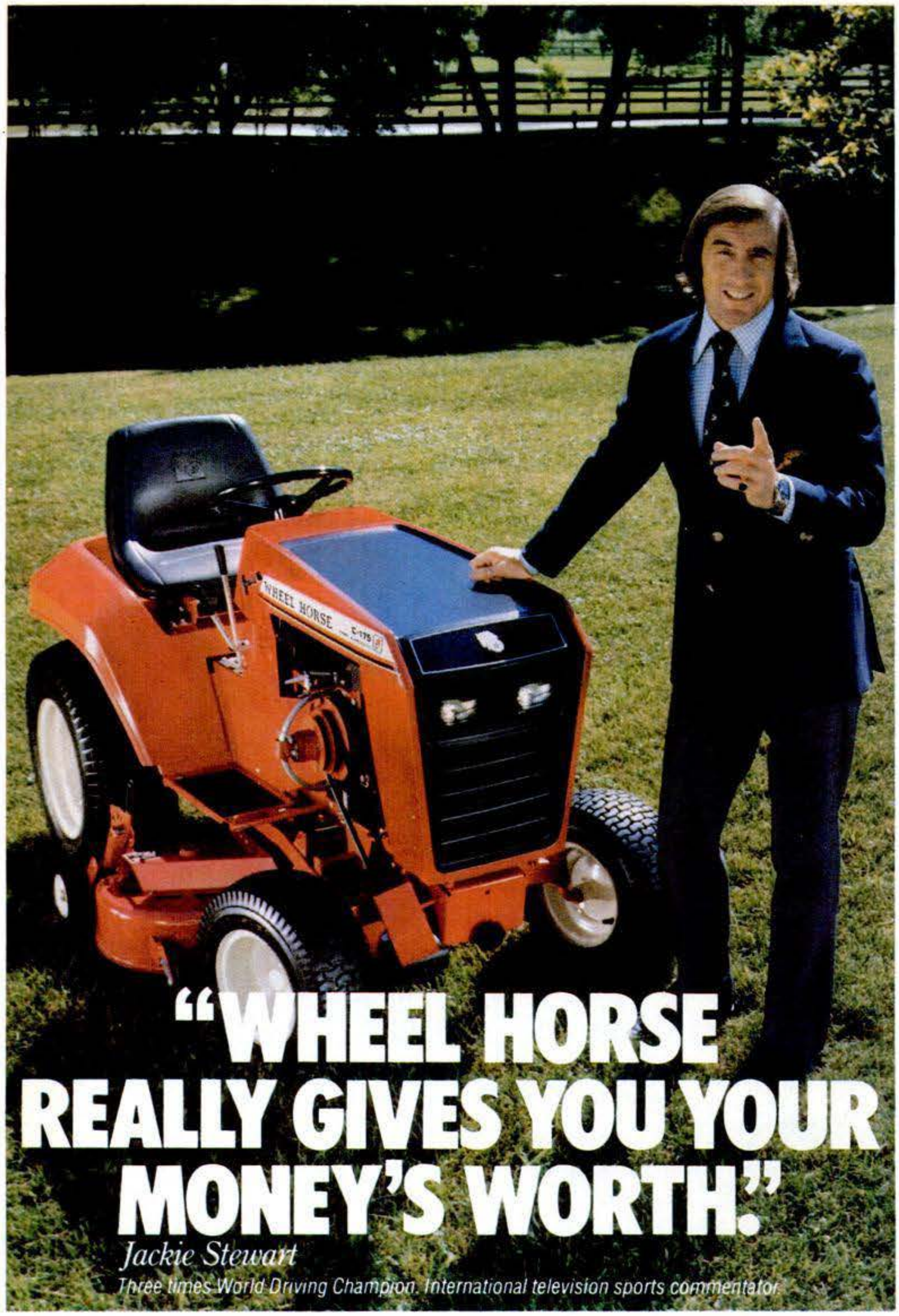

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Detroit report

[Continued]

and probably a quieter ride. The mini-Blazer's versatility is severely limited compared with the full-size Blazer, however. One unusual visual difference: 14-in. wheels look king-size on the smaller body.

Here we go again

GM plans to offer engines that will require high-octane gasoline in 1983 and later models. That means you'll have to buy premium-priced 93-octane unleaded brands instead of 87-octane regular unleaded. Cost per gallon will be about five to seven cents more. The reason: GM wants to put more compression, up to 9.5:1, in its engines. That calls for higher-octane gas if engine knock is to be controlled. High compression will pay off in more power and better fuel economy, but it's doubtful that either improvement will offset the cost of premium unleaded.

Softer Fords for '83

You'll see it in the new Thunderbirds, Cougar XR-7's, and compacts: a softening of body lines to lower the coefficient of drag. Aerodynamics becomes more important for fuel economy as cars get lighter. One reason: Small engines must struggle to buck a head wind. So Ford is going all out to be a leader in aerodynamics. No more "three-box" shapes, with the hood, passenger-compartment, and trunk profiles highly defined. Instead, the cars will have a more integrated look and will show less abrupt divisions between each section. Grilles will have a rounded profile, while hood lines and front fenders will sweep gently from the base of the windshield down to the top of the bumper.

Look for these names

Ford and Mercury will name their new front-drive compacts Tempo and Topaz if current reports hold true. The front-wheel-drive cars are set for 1983½ introduction and will replace Fairmont and Zephyr. The cars are bigger versions of the Escort/Lynx, but their appearance will be completely new and will feature highly aerodynamic body lines and a bustle trunk. Four-cylinder engines will be standard, with four-speed manual transmissions. The new line will allow Ford to match GM's X-cars and Chrysler's K-cars.

Is plastic better than steel?

Owens-Corning will soon find out as its prototype plastic car doors go through tests by Peugeot. The French firm is examining plastic door panels for its subcompact 305 sedan. The American firm used two different plastic types for tests for the front and rear doors of the 305. Major advantages: two-piece construction instead of the 15 pieces needed for the current steel doors; less energy needed to produce and maintain the door for a typical life of the car; and weight savings of better than 35 percent. PS

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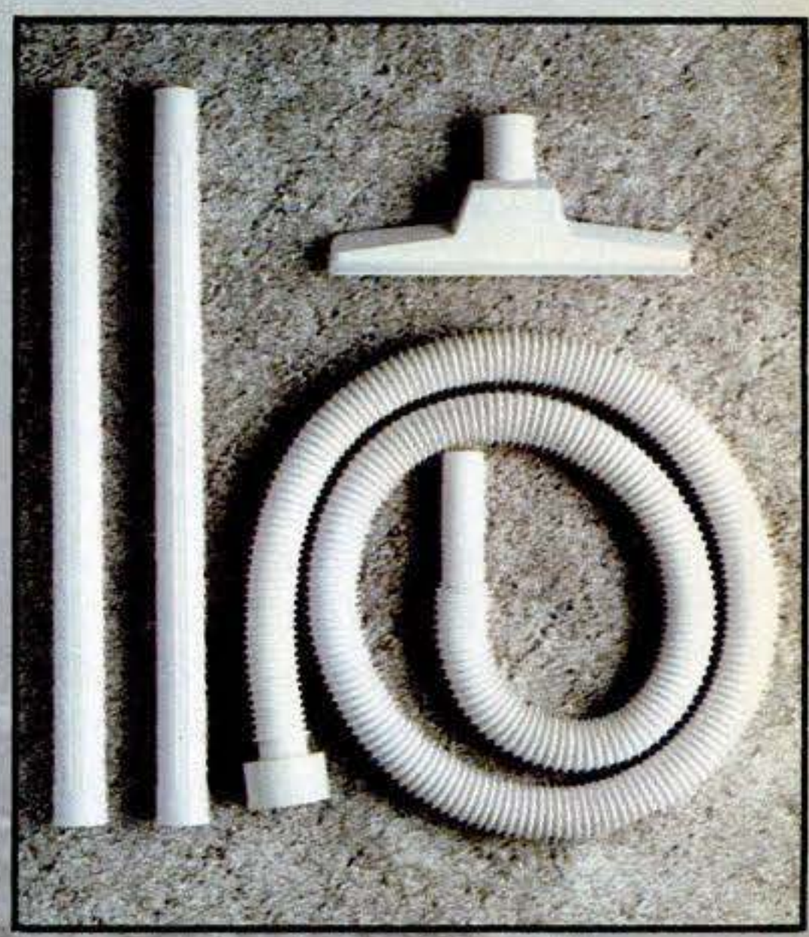

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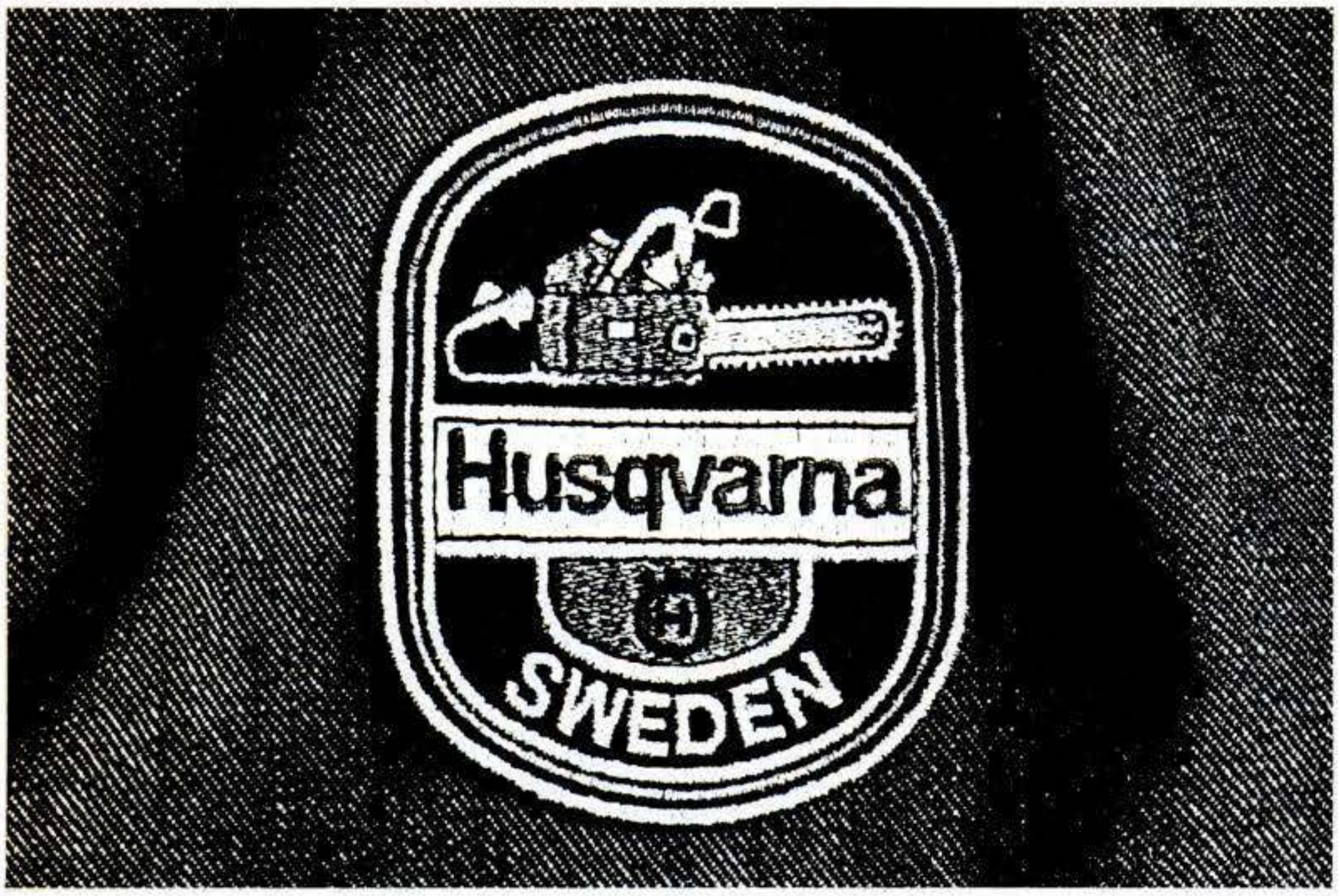

One word of advice on how to buy a chain saw.

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That's a Swedish word. For some very good reasons, it's come to mean "the finest" whenever the subject of chain saws comes up.

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Now you can purchase a Husqvarna chain saw. But don't look for one in a chain store. We believe in service, so you'll have to visit a Husqvarna dealer/service store. Only dealers like ours can ensure rapid and expert service so your chain saw will be ready for you when you need it.

See for yourself. You'll find that when we say we make a very fine chain saw, we're as good as our word.

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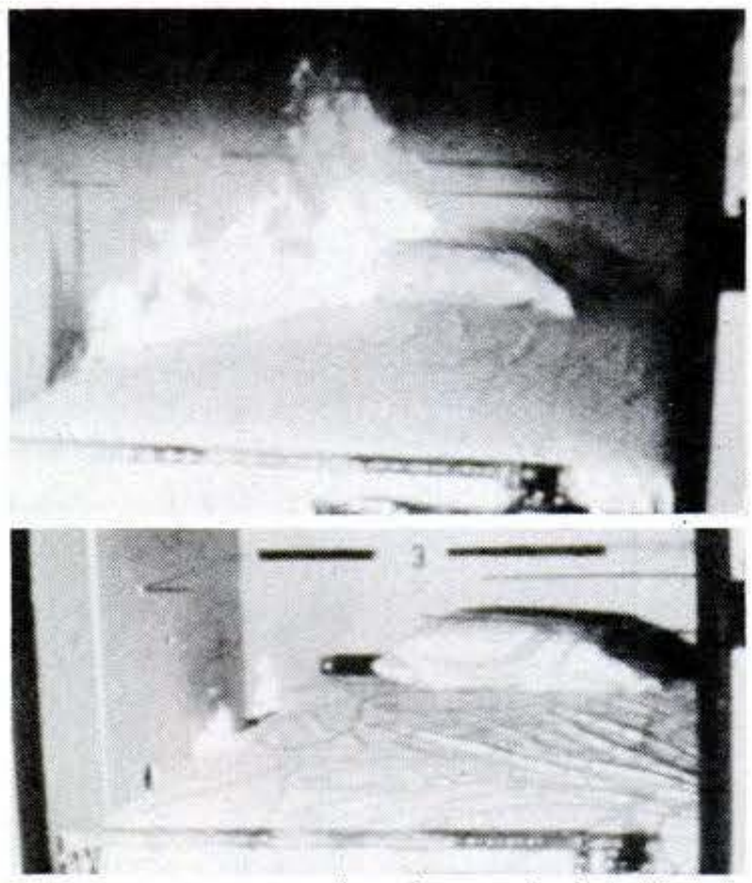
Fire-fighting mattress



Flaming mattress (top) was ignited by a wastebasket fire in just four minutes during test of standard fire-resistant mattress. In eight minutes, super-heated air caused flashover, setting the whole room ablaze. In an identical test of a Sandel-ticking mattress (above, after 13 minutes) flames licked at the sheets for a full 30 minutes without igniting the mattress. The fire then died out without even charring the mattress. It can withstand temperatures to 1,200 degrees F, maker says.

Next time you stay in a hotel, you may sleep on a truly nonflammable bed. Covered with woven-fiberglass ticking, the new mattress-and-box-spring set won't burn even when open flames attack it, claims the maker (Guest Guard/Family Guard, 2350 5th St., Rock Island, Ill. 61201).

Hotel mattresses (but not box springs) must already meet federal flammability standards. These require a mattress to withstand a smoldering cigarette. Open flames aren't mentioned.

Many federally approved mattresses have PVC coatings that will not burst into flame. But they will char and give off deadly smoke. In contrast, the new fiberglass ticking emits minimal smoke (compare photos).

Why the dramatic difference? Simple: Fiberglass won't burn. Until now, though, it was just too brittle and abrasive for mattress ticking. The new Sandel ticking is made of extremely fine fibers coated by a special process that makes the fabric resilient and durable.

The new beds were tested by Owens-Corning Fiberglas Co. and by Sears. Family Guard, the consumer version, should be in stores this fall.—*Susan Renner-Smith*

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Popular Science

PS | What's News

A diesel aircraft engine? It's been tried before. But it always failed because diesel engines are too heavy. They have to be massive to withstand the high pressures that are a necessary part of the diesel's operating cycle.

Still, the need to develop some kind of alternative aircraft engine is great. High-octane aircraft fuel is simply disappearing. It probably won't be available at all in a few years. So NASA set out to promote the design of an engine that could operate on jet fuels or other, easier-to-make fuels, and at the same time get better gas mileage.

Various research teams developed different approaches, but the most promising at this time is a diesel being developed by Teledyne. How did engineers get around that weight problem? By designing a novel diesel/turbine engine that brings some surprising operating principles into play. Engineering Editor Al Lindsley visited the Teledyne lab to get the details on the new effort, and his report starts on page 103.

We thought the development important enough to rate cover treatment. But an engine such as the one you see pictured there doesn't exist in this form. As the piece explains, it is now only a laboratory developmental model. That meant the cover would have to be painted.

The illustrations of the new diesel, both on the cover and inside, were done by Jeff Mangiat. This is Jeff's first POPULAR SCIENCE cover, and we welcome him to the select group of artists whose work has appeared on the cover of PS.

Are the polar icecaps melting?

Maybe. Two scientists from the National Oceanic and Atmospheric Administration have recently reported on their studies, which indicate that about 20,000 cubic miles of polar ice may have melted in the past 40 years. This is scary, because it could be the first actual evidence that the increasing concentration of carbon dioxide in the Earth's atmosphere, brought about by the burning of fossil fuels, may actually be turning the Earth into a gigantic greenhouse in which average temperatures will begin to rise [PS, Feb.]. If so, it could have important but unpredictable consequences for the future of the Earth.

The scientists, Robert Etkins and Edward S. Epstein, caution that they can't be sure that the ice has actually melted because the data at this point are too unreliable. But the evidence is troubling. Rhodes Fairbridge and O. A. Krebs of Columbia University have made measurements that indicate that the oceans have risen 6.5 inches since 1890. About half of this would be due to the expansion of sea water that would have accompanied a warming trend. The rest might be from melting polar ice. At the same time, the spin of the Earth has slowed, lengthening the day by a fraction of a second over the last 40 years. This, too, would have happened if enough polar ice had melted and the mass formerly concentrated at the poles were distributed in a thin layer over the ocean surface. The force is identical to that acting on a spinning skater who spreads his arms to slow the spin.

But not all the evidence points in this direction. Glaciologists have been unable to detect any increase in the rate of glacier flow, which is a pretty good indicator of how much ice is moving into the sea and melting. And, as one specialist points out, average global temperatures may have risen a fraction of a degree, but this would have no effect on polar ice, because the temperature there is still far below freezing.

The question is not going to be resolved soon. But it does point to the fact that we must continue to study the whole carbon dioxide/climate-change affair until we know for sure what is going on and what long-term effects it may have on the world's future.

Wind power: Is bigger better?

Maybe not, some of the experts are beginning to believe. The Department of Energy has tended to put most of its development money into huge projects, such as the three 2.5-megawatt turbines at Goldendale, Wash., built by Boeing [PS, Nov. '81]. Such machines stretch the state of the art and have had many technical problems. Smaller machines, on the other hand, are easier to build, well within the state of current engineering practices, and are proving to be economical in many applications. *Engineering News Record,* an authoritative journal, estimates that some 2,000 such units were sold last year, representing a 50 percent increase over the previous year.

Manufacturers of units now on the market are frightened by threats by the Reagan administration to eliminate the tax credit for those who buy and install windmills, since such a move would probably depress sales. But not everybody is so negative. Says Forrest S. Stoddard, an engineer who founded a wind-power company, "The technology, as it exists for small-scale wind turbines, is competitive without credits." In fact, he adds, "Loss of credits might not be so bad for the long-term health of the industry. The credits attract the money, but investor emphasis is on the credit—available whether or not the project is successful—and not on the quality of the engineering."

Short updates

- The Wankel may again be on the rise. But not as an engine. Five years ago, when General Motors abandoned its Wankel project because the rotary engine produced emissions too high and mileage too low, the ingenious device went into a long decline [PS, Sept. '78]. But now it seems destined to be heard from again—as a compressor. A German company is building air compressors based on the Wankel principle, and a Japanese company recently went into production with a compact Freon compressor for automotive air conditioners. The tiny compressor fits easily into even the most crowded engine compartment. The company already has an order for 50,000 of the compressors from Ford of Taiwan. Wankel proponents still entertain some hope for its use as an engine, but that prospect doesn't look as bright.
- The first cargo vessel to be retrofitted with a sail was recently tested in Buzzards Bay, Mass. The sail was designed by Wind Ship Development Corp. [PS, Dec. '80] and installed on a 200-foot Greek ship. The sail, which is unfurled from a 116-foot mast, is expected to cut energy consumption by 20 percent while maintaining normal speed.

Editor-in-Chief

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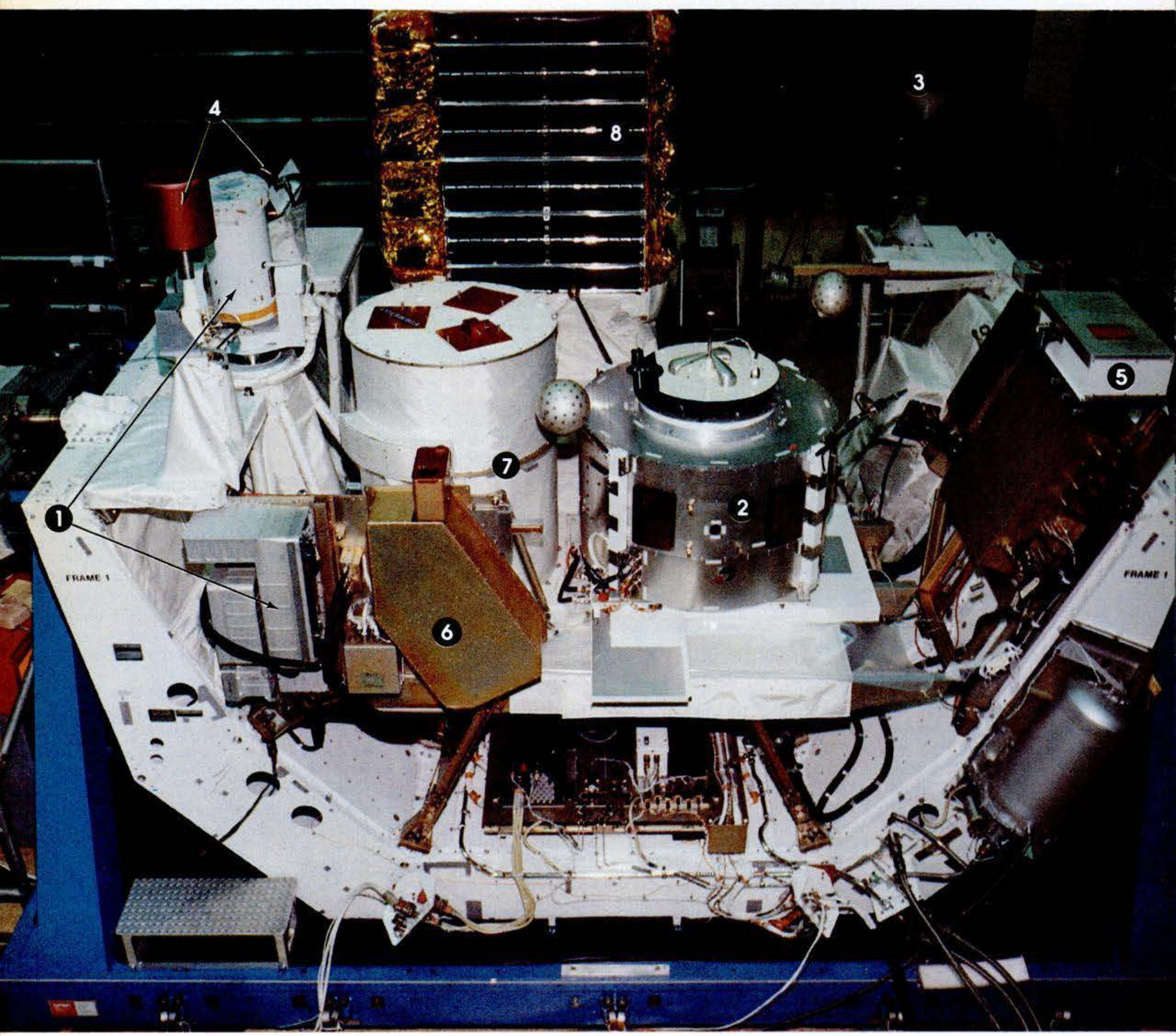
Shuttle flight #3 puts

science in orbit



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Now the shuttle must begin proving its value as an orbiting test bed and a vehicle for scientific-data gathering

By JIM SCHEFTER

Tilted slightly nose down toward the approaching horizon, its open payload bay fully exposed to the sun's heat and illumination, the space shuttle Columbia glides through orbit. An occasional 40-foot stream of blue-orange flame spewing from one of the orbiter's attitude-control rockets is the only outward sign of activity.

Then something moves. Articulating out from the bay, a thin, multi-jointed metallic arm sweeps up into view. It pauses, moves on, pauses again.

For long minutes the arm probes this way, then that, like some wary insect checking for danger. At last satisfied, it disappears back into the cargo hold.

That arm is no independent device. It responds to the delicate control movements of astronaut Gordon Fullerton, peering through rear ports on Columbia's flight deck. He'll repeat those maneuvers several times during the next mission of America's reusable spaceship. Gripped in the arm's grapple-end will be an instrument checking nearby space to determine how much contamination the shuttle produces. That information is critical to the calibration and design of future shuttle payloads.

This third flight of Columbia is also the beginning of a new kind of orbital exploitation. For the mission is more than a test of how well the space transportation system (STS) works. STS-3, planned for early spring, carries major scientific payloads and demands that astronauts Jack Lousma and Gordon Fullerton play dual roles as engineering test pilots and in-orbit researchers.

"Each flight expands the envelope of capabilities," mission planner John Whitely of the Johnson Space Center told me. "We've already found that the orbiter uses much less electrical power than expected, for instance."

Problems with the fuel cells that generate that power forced an early end to the STS-2 flight last November. If those troubles don't repeat themselves, Lousma and Fullerton will have plenty of time to get their work done. Their mission is planned to last more than seven days, most of it in a circular orbit 150 miles up.

The science objectives for STS-3 fill much of that time. Some of the test devices flew earlier aboard Columbia. But most of them are new for this mission, partly intended to demonstrate Columbia's value as an orbiting test bed, partly to gather new and vital scientific data. The major addition is a collection of instruments provided by NASA's Office of Space Sciences and dubbed OSS-1.

Most of the OSS-1 gear is mounted on a prototype pallet developed by the joint U.S.-European Spacelab project. The curved pallet fits snugly in Columbia's payload bay, where its instruments are operated remotely.

OSS-1 instruments include three that will sample and evaluate portions of the environment around Columbia. In each case, the data are needed to help scientists understand the effects the space shuttle itself may have on delicate instruments or experiments flown in the future.

The Plasma Diagnostics package checks on electromagnetic background, the Vehicle Charging and Potential experiment looks at how the orbiter affects electrical charging of its own surface and equipment, and the Characteristics of Shuttle Induced Atmosphere experiment looks at how sunlight is scattered by orbiter particles.

The latter two instruments remain fixed to the pallet. But Fullerton will use the robot arm, the Remote Manipulation System (RMS), to grapple onto the plasma package, pluck it free, and then sweep it through a planned 50-foot arc above and beside Columbia. During that time, the package will feed data through cables in the robot arm on how the orbiter's own radiated emissions affect nearby electric and magnetic fields and the local plasma. Finally, Fullerton will replace it on the OSS pallet, where it will resume automated data gathering.

"The RMS gets a lot of activity on this mission," Whitely said. "They'll be testing the arm at the same time they're getting good use from it."

Spectral and X-ray observers

Two solar-physics instruments are aboard the OSS pallet to take advantage of the high solar-flare activity that's expected. One device will measure solar ultraviolet light and other spectral segments, while the second will observe solar X-rays and their polarization. The UV data are important to understanding how solar radiation and its variability can trigger long-range changes in the Earth's atmosphere and climate.

The X-ray device measures polarization during solar flares. Scientists hope for a major advance in understanding the physical process that drives the flares. Solutions to two fundamental puzzles are being sought: the nature of the mechanism that energizes the solar-flare particles, and how they produce the observed emissions.

The remaining pallet-borne package is a thermal canister designed to evaluate heat-pipe technology in controlling and dissipating heat in zero gravity. Heat pipes carry heat away by vaporizing and re-liquefying fluids in a closed loop. Such a system can have great value in space by maintaining a constant temperature within a canister of instruments that might otherwise overheat. But heat pipes themselves need more analysis under space conditions to determine their limits.

The final OSS experiment is carried in the crew cabin and requires minor gardening abilities from Lousma and Fullerton. Called the Plant Lignification experiment, it is a unit containing fertile oat and bean seeds and recently germinated pine sprouts. This little space farm is a box containing six thin, rectangular modules. The astronauts will turn on the unit shortly after reaching orbit. During their week in space, they'll give the seeds about 14 hours of artificial sunlight each day and will photograph plant growth at frequent intervals.

The purpose of the experiment is to see how gravity—or non-gravity—affects the formation of woody lignin in different plant species: Scientists have theorized that lack of gravity will yield plants with less lignin. Lignin is necessary where woody structure is needed, but it is an undesirable waste in many plants—those used for food or to make alcohol fuel, for example. If the mechanisms that control lignin production in plants can be isolated, according to Dr. John Cowles of the University of Houston, there may be applications for lignin reduction both on Earth and in future space colonies.

Another major in-cabin experiment requiring close attention from Lousma and Fullerton is an Electrophoresis Equipment Verification test. Potentially the forerunner of

Continued

OSS-1 pallet, prepared by NASA's Office of Space Science, contains these experiments: The Shuttle Induced Atmosphere experiment (1), Plasma Diagnostics package (2 and 3), and Vehicle Charging and Potential experiment (4 and 5) will sample and evaluate portions of the environment around the shuttle. The Solar Ultraviolet Spectral Irradiance monitor (6) and Solar Flare X-ray Polarimeter experiment (7) will capitalize on expected high solar-flare activity. The Thermal Canister (8) will evaluate heat-pipe technology as a method of heat dissipation in space.

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major medical advances in orbit, this same equipment originally flew on the Apollo-Soyuz Test Project in 1975.

"We're trying to isolate kidney cells that are high producers of the enzyme urokinase," cell biologist Dr. Dennis Morrison of the Johnson Space Center told me. Urokinase is a rare and expensive enzyme used, among other things, to dissolve blood clots in stroke victims. But only five to 10 percent of kidney cells actually produce the enzyme and the process "is drastically compromised by gravity on Earth," Morrison said.

The electrophoresis test runs an electrical charge through a solution of kidney cells. Cells with different proteins on their surfaces apparently carry different electrical charges, Morrison explained. Those cells that produce urokinase should generally group together.

In the 1975 Apollo-Soyuz test, two columns of kidney-cell cultures were subjected to an electrophoresis current. One column came back showing six to seven times more urokinase production than found in earthly cultures, Morrison said, supporting the theory that different cells can look the same under a microscope but still have different electrical charges. However, those results were questioned because the hollow needles used to carry buffer fluid to and from one column became partially blocked. The fluid failed to circulate properly, turned acid, and killed the kidney cells. Scientists rebuilt the columns to eliminate the problem.

Now Lousma and Fullerton will test the electrophoretic device again, processing six columns of kidney cells. In each case they will insert a frozen column of cells into the device, thaw it briefly, then subject the sample to a voltage gradient of 260 volts for an hour.

"When you do this on Earth, you usually get a sediment in the column that works against you," Morrison said, "and you get thermal-convective mixing, exactly the opposite of the separation you want."

At the end of the hour run, Lousma or Fullerton will flip switches to quick-freeze the sample column, then store it in a freezer locker.

"If this technique works, we'll be able to say the Apollo-Soyuz test results were valid," Morrison said. This process will never produce enough urokinase for commercial applications, he adds, but it can provide producing kidney cells for research, help identify which cells produce urokinase, and perhaps provide cells for seeding urokinase cultures on Earth. And it can provide valuable information for more advanced tests involving electrophoresis planned for future shuttle flights. Frozen samples will be rushed back to Houston, and results will be available about 30 days later, according to Morrison.

Two more science packages are aboard Columbia:

Getaway Special (GAS) canister. Getaway Specials are small, self-contained experiments being prepared by schools, corporations, and private individuals for flight on a space-available basis in coming years. The basic canister and electronics will be tested for the first time, though no actual payload will be carried until the following mission. Fullerton will use a hand-held keyboard that sends commands to the canister (mounted in the payload bay) and initiates data collection.

Monodisperse Latex reactor. Stowed in the space of three mid-deck lockers, this package draws shuttle electricity to combine polystyrene seed latex particles about two microns in diameter with a styrene monomer and other chemicals to produce uniform microscopic latex spheres under zero-gravity conditions. The reaction is unreliable in normal gravity, producing beads of non-uniform sizes, but none larger than two microns. Lousma or Fullerton will turn on the unit at their convenience, and it will operate for 12 to 13 hours. During that time, the mixtures will be heated and stirred automatically. "We're hoping to grow latex particles larger than can be grown on Earth," said chemist Dale M. Kornfeld of the Marshall Space Flight Center in Huntsville, Ala. "Particles of that size will have a number of commercial applications." Among these are uses in diagnostic testing, cell research, and calibrating cell counters, filters, and electron microscopes. Tiny and readily absorbed into the body, they also may be useful as drug carriers in cancer-treatment research.

Testing the ship

When they aren't handling scientific duties, Lousma and Fullerton will attempt to complete a full slate of engineering tests. One major series involves collecting data on the orbiter's thermal balance. Some information was also gathered during the two earlier flights.

"There was no money to build a giant thermal chamber on Earth," Whitely said, "so the shuttle is the first spacecraft to get its testing in orbit."

Lousma will position Columbia in a variety of attitudes with respect to the sun. Some positions will be held for 24 hours or more, letting solar heat soak the craft to determine how it reacts. Other positions will include the classic barbecue mode: The spaceship will be rotated slowly to spread solar heat uniformly over its skin.

Another major category of engineering tests will have Lousma firing Columbia's 870-pound-thrust reaction-control rockets—the rockets that control the ship's positioning. He will give the system a true workout, including prolonged firings, multiple engine firings, and rapid restarts. Data on thrust levels and fuel flow will be recorded.

Other engineering tasks included in the STS-3 schedule:

Induced Environment Contamination monitor. Like the scientific Plasma Diagnostics package, this experiment will sample the environment in and around the orbiter. But while the plasma experiment measures electromagnetic effects produced by the orbiter, this one will measure gaseous and particulate contamination so engineers can assess whether they're within design guidelines. The monitor, carried in a fixed position on an earlier flight, now will be picked up and moved around with the robot arm to gather data out to 50 feet away. Fullerton also will turn on the unit from the cockpit a number of times without moving it. For several samplings Lousma will use Columbia's thrusters to reposition the ship. "It will take some precise control on his part," Whitely said.

Aerodynamic Coefficient Identification package. Fullerton will turn on this experiment, but from that point it will be controlled from Houston. The package includes accelerometers and rate gyros to gather data on Columbia's aerodynamic characteristics during hypersonic, supersonic, and transonic flight. The information will help refine the shuttle's flight-control software and may affect future spaceship or aircraft design.

Tile Gap Heating Effects test. A test panel of thermal-protection tiles, with various edge radii and gaps between them, is mounted externally. Sensors will automatically gather heating and turbulence data during entry and landing. The data may allow some tile redesign to reduce entry heat loads.

Catalytic Surface Effects experiment. While gaps between the tiles may be admitting too much heat, entry data from the first two shuttle flights indicate that the thermal tiles themselves may be over-designed, perhaps allowing future orbiter tiles to weigh less. Certain instrumented tiles have been coated with a catalytic overlay for a test of improved efficiency.

"It's a full mission," Whitely summarized. "But so far, on these flights, we've stayed well within our capabilities. STS-3 may be reaching some test limits, but it's nowhere near its overall potential."

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Super lamps
—science reinvents the light bulb

Will fuzzy filaments and ferrite rings help trim your electric bills?

By JOHN FREE

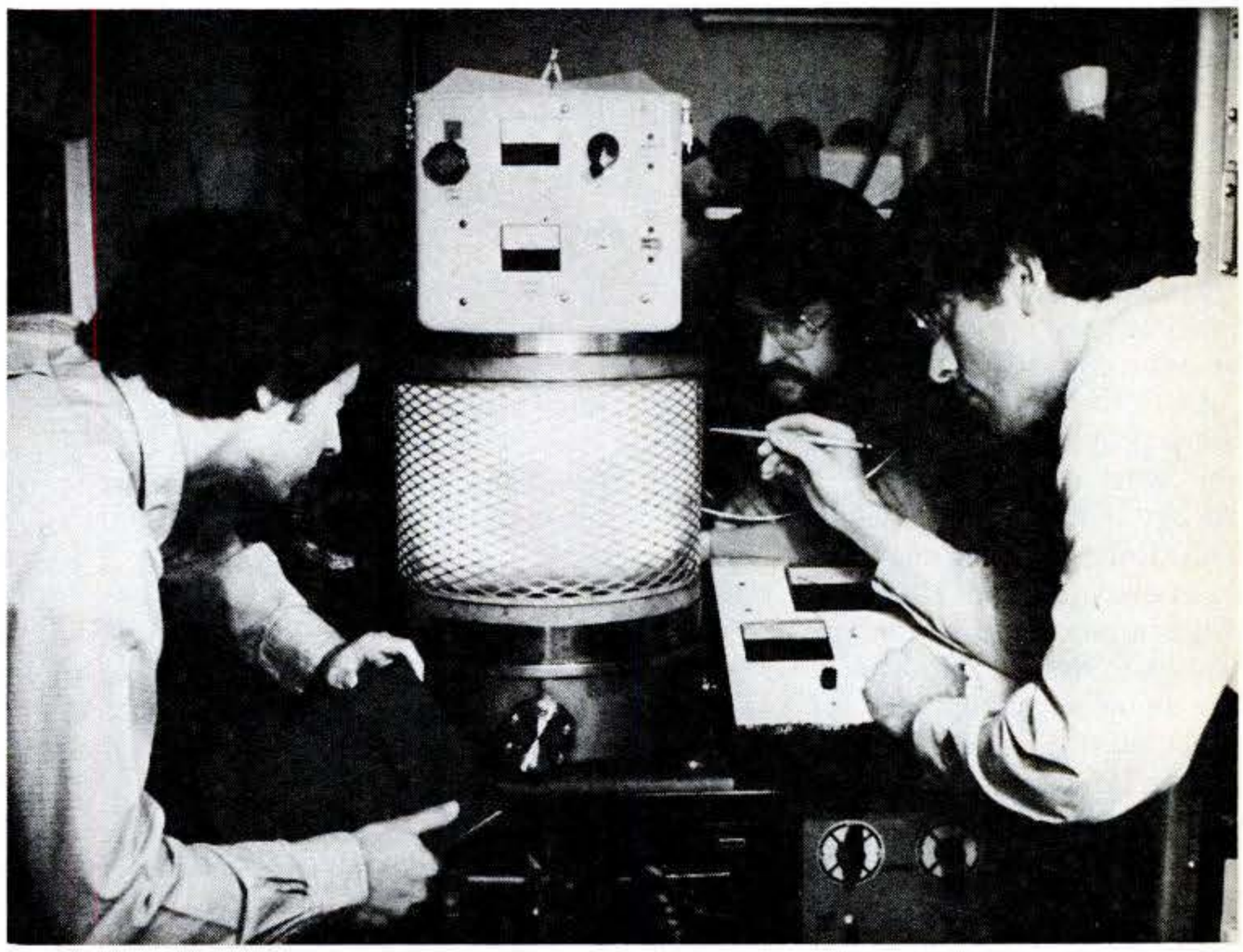
HOLMDEL, N.J.

A violet glow from the plasma in a vacuum chamber illuminated a small room at Bell Labs. Moments before, researcher Richard Howard had switched on a pump, evacuating the glass container. Argon, oxygen, and Freon were fed into the vacuum jar. Now these ionized gases hovered a few inches above the chamber base, like a neon-lighted fog over a city.

Put a prepared sample of tungsten beneath that plasma, wait one minute, and the metal turns pitch black, I discovered. The plasma etches an invisibly fine, "fuzzy" texture into the tungsten's surface. That gives the metal a remarkable property: Heat it to incandescence and it will radiate twice as much visible light as ordinary smooth tungsten.

Not that Bell Labs is gearing up its parent, AT&T, for the light-bulb business. What happened was that, a few years ago, Bell began studies to develop materials that would selectively absorb wavelengths of solar radiation. Along the way, a new etching process was discovered that may one day provide more-efficient home lighting.

This is just one example of the kind of research that may one day radically alter the guise of that most familiar of great inventions—the light bulb. The need is pressing. As energy costs continue to climb, low-cost but poor-efficiency incandescent lamps become less and less practical for the home. So the search is on for new techniques and materials that will yield greater light output while using less energy.



Glowing plasma, viewed by Bell Labs scientists, can etch textures smaller than light wavelengths on tungsten, which can then radiate light more efficiently.

Most basic lighting research is, naturally enough, conducted in the labs of General Electric, Sylvania, Westinghouse, Philips, and other lighting firms. Each has announced economic alternatives to the incandescent (see "Energy-Saving Lighting," PS, Sept. '80). But I wasn't surprised when these companies declined to talk about their advanced projects. The lamp business is very competitive. Industry experts discuss only basic research and areas where studies might pay off in general terms. Some examples:

- Developing phosphors that can absorb and use infrared as well as ultraviolet radiation, plus more-efficient phosphors for fluorescent lamps.
- Discovering molecules beyond the limited number already used that either radiate visible light or fluoresce under ultraviolet.
- Perfecting solids and even liquids that radiate light efficiently.

Locking in the infrared

The modern incandescent lamp has climbed steadily in efficiency compared with the carbonized thread—delivering 1.5 lumens per watt—used by Thomas Edison in 1879. The slightly more-efficient GEM filament was graphite-coated cellulose. Early refractory metals such as osmium and tantalum gave better efficiency. The

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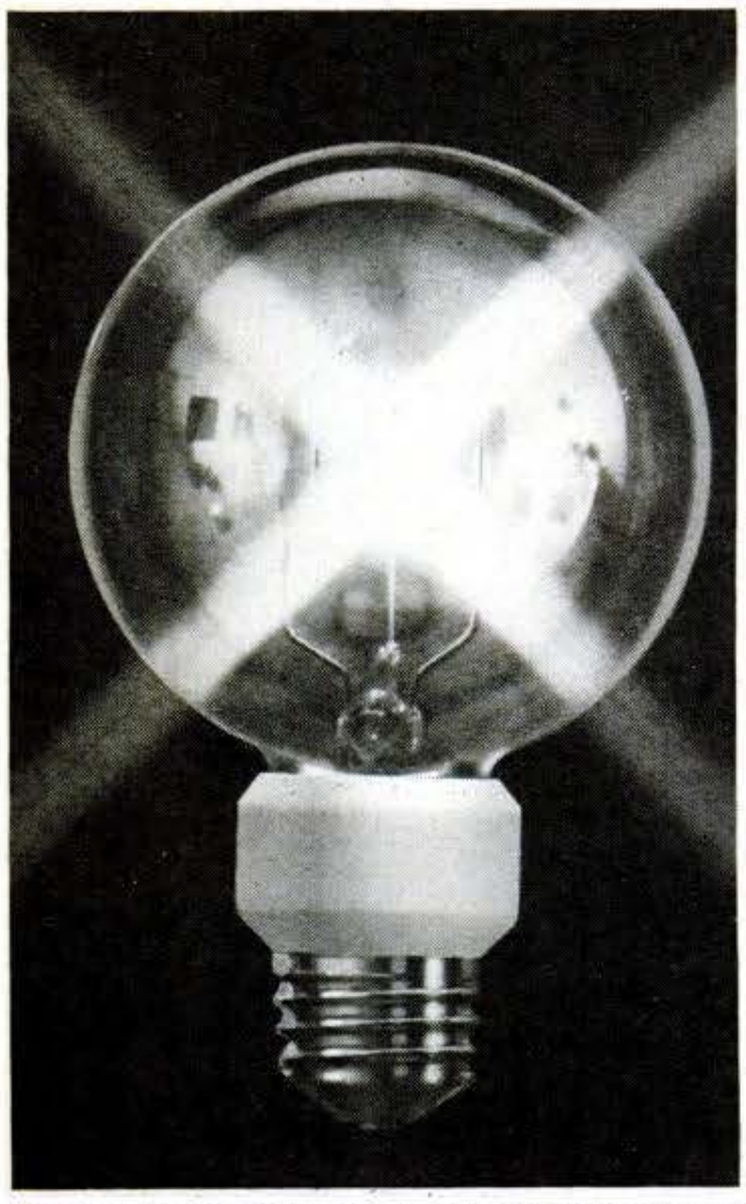
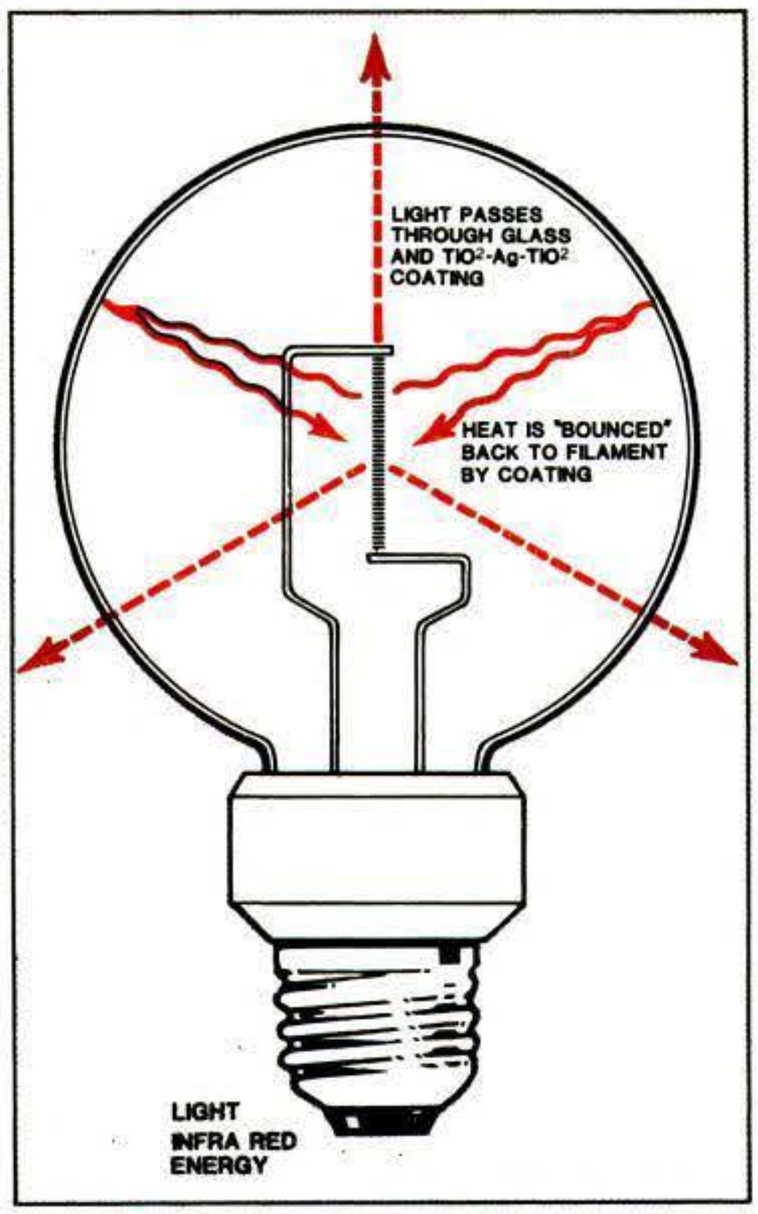


Energy-saving lamp under development at Duro-Test Corp. requires less power to keep tungsten filament incandescent.



Heat-reflective coating inside Duro-Test bulb is made with silver (Ag) and layers of titanium dioxide (TiO_2).

Nernst lamp used a glowing rod made with oxides. Lighting engineers have continued to make progress until the present day (see graph).

Still, the modern tungsten-filament lamp provides only about 17 lumens per watt. About 80 percent of its energy is wasted as invisible infrared radiation. Why not capture this wasted energy and put it to work heating the filament and lowering your electric bill? Researchers have been trying to accomplish this for some 50 years, and one firm, Duro-Test Corp. (North Bergen, N.J.), says it has found a practical method.

The Duro-Test Mi-T-Watt Saver bulb, being readied for manufacture, uses a three-layer coating on its inner surface. This thin-film coat was originally developed at MIT for solar-energy applications—an example of fortuitous research analogous to Bell Labs'. The middle, silver, layer reflects infrared radiation, and the bulb's spherical shape (see drawing) focuses this energy on the filament.

Titanium dioxide has a high index of refraction. Thin layers of this material on either side of the silver serve as an anti-reflection coating. It helps visible radiation from the filament to penetrate the glass envelope.

Duro-Test says that energy savings of up to 60 percent are possible when reflective-coating bulbs are compared with conventional bulbs, and experiments yielded a net energy saving of 51 percent. Whether similar savings become feasible with mass-produced bulbs remains to be seen.

A key step, applying the coatings, might be accomplished by sputtering atoms from a cathode with RF (radio frequency) energy, by chemical vapor deposition, or by thermal evaporation. The bulbs will also have to be mass-produced with each filament at the focus of the film for full efficiency.

While Duro-Test refines its bulb that keeps heat in, several researchers at Bell Labs believe they've found a better way of getting visible light out of incandescent lamps. The etching process described earlier makes the smooth surface of tungsten, under an electron microscope, look like a carpet. Tungsten "tufts," though, are so small that five of them can stand side by side along a one-micron (millionth of a meter) line.

These cone-shaped metal columns produce a gradual physical transition from the tungsten to a vacuum in which the metal is resistively heated. As a result, visible light over the 0.3–0.7-micron range is emitted twice as effectively as from ordinary tungsten. Bell Labs' Harold Craighead compares the light radiation to sound waves from a horn: Gradual flaring at the output of an instrument permits air to flow smoothly into the air.

While the textured surface enables visible light to escape more easily, longer wavelengths do not. Tungsten, therefore, won't radiate and waste more heat. But there are obvious problems, too: "It's entirely clear that this surface is more delicate than solid tungsten," says Craighead.

Could the ultra-fine structure last long enough for a practical lamp filament? "It's open to someone doing R&D work on it," Howard said. "We're just not in the light-bulb business." He says the textured surface enables tungsten to be used at lower temperatures yet put out more light than smooth or uniformly black surfaces.

The etching technique, incidentally, will also be applied to creating the submicron structures needed for very-high-density microcircuits, or perhaps to "fuzz" a metal coating on a plastic disc for an optical digital recorder, or to create high-surface-area catalysts. Bell has other uses in mind, too, but isn't talking about them now.

Fluorescent lamps, with 80-lumen-per-watt efficiency, offer economic advantages over incandescents. About 66 percent of electrically produced lighting throughout the world is from fluorescents.

"Since its introduction, the primary performance improvements in the fluorescent lamp have been in phosphors and the durability of the electrodes," said John Waymouth of Sylvania. Lamp performance is limited by characteristics of materials used in fluorescents. "Further improvements in performance will depend on further improvements in those characteristics, especially phosphors," he adds.

Look—no electrodes

Shrinking long fluorescent tubes into compact sizes suitable for the home can reduce lamp efficiency. One reason is that losses occur at both ends of any tube, near the electrodes. Bringing the electrodes closer together and reducing the surface area of phosphor cuts efficiency.

GE's experts showed me an ultra-compact fluorescent that avoids this end-loss problem by eliminating electrodes. The lamp, about the size of an incandescent 100-watt bulb, has an electronic ballast [PS, July '81] just above its screw-in base. A quarter-size ferrite core in GE's SEF (solenoidal electric field) lamp is the primary of a transformer, while the mercury/noble gas itself acts as the secondary.

"We had to develop phosphors that could withstand high power density," GE's John Anderson told me. The SEF bulb, which is still too inherently costly for mass production, delivers 50 lumens per watt. A 40-watt SEF bulb, therefore, puts out 2,000 lumens. By comparison, a 100-watt incandescent provides 1,750 lumens.

Scientists are still exploring the enormous range of substances that can be used in lamps. The great variety of additives used in tungsten-halogen lamps, for example, produced similar results, but researchers still

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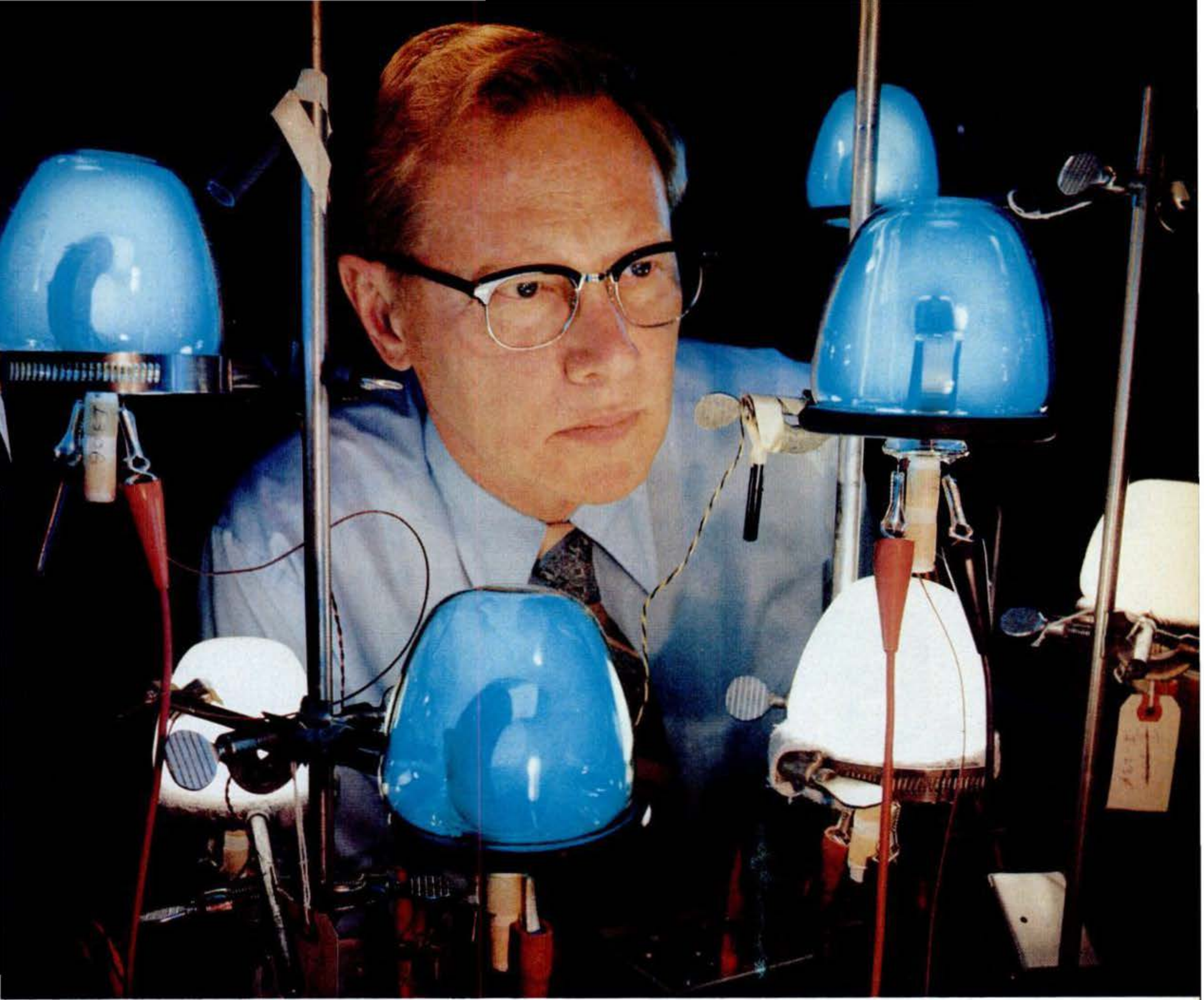

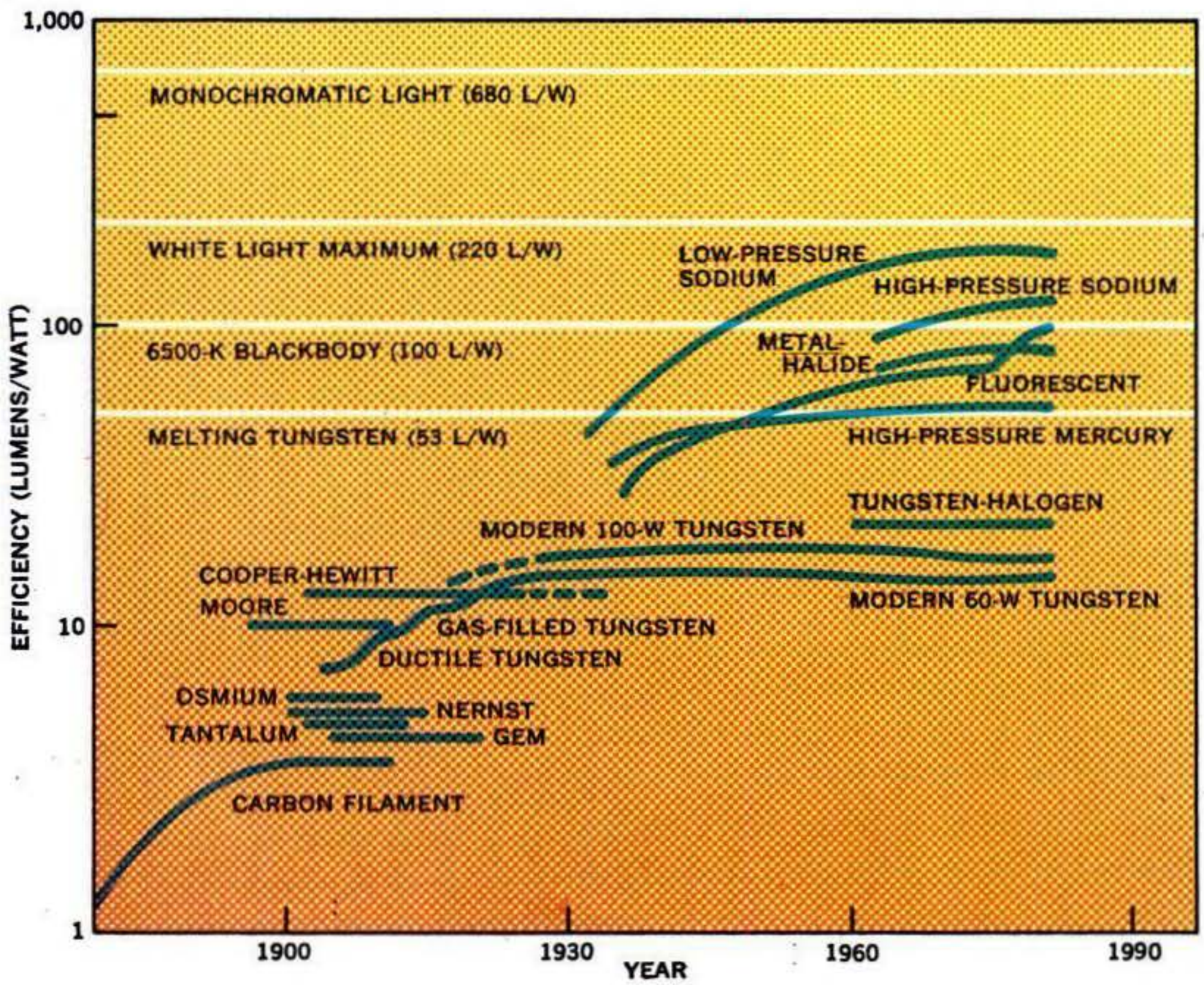

Experimental lamps that promise savings through lower operating costs and longer life are inspected by physicist John Anderson at GE's research center.

Lighting-technology evolution shows efficiency improvements over time, plus several standard light sources.

aren't sure how complex chemical reactions work in these lamps. Skill gained in selecting different additives will enhance the color output and lifetime of both tungsten-halogen lamps and the more-efficient metal-halide arc lamps.

So, what's coming along to replace inefficient incandescents in the home? "Based on past experience, we might soon expect the beginning of a decade or so of revolutionary progress in light-source technology," said John Waymouth of Sylvania. "In all likelihood, the first system to overcome its technical problems *and* break the critical cost barrier will capture a large fraction of this very large market," he adds.

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Passive-solar house with ingenious **under-floor heat bank**

First design of horizontal rock bed used 220,000 lbs. of river rock in a tree-shape layout. Cool air rising through the 24 ft. of collector height is heated by up to 70 deg. F, then enters duct system for heat transfer to rocks and return to bottom of collector. Large ducts and gentle curves compensate for low pressure of air flow. Average flow path through rock-bed sections is four feet (ample for good heat transfer), but path is shorter in parts of bed farthest from collector to allow for heat and pressure loss during passage through ducts. Thus, all parts of bed get equal thermal charge. Measured temperatures inside house showed variation from north to south rooms of less than four deg., day-night swing in a given spot of about three deg.

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It's the ultimate thermosiphon system: 100 percent solar without big thermal swings

By BENJAMIN T. ROGERS
ILLUSTRATION BY DEAN ELLIS

Buck Rogers, a consulting engineer, was an early advocate of natural-convection solar systems.

Mark Jones has done it, and Scott Morris can prove it.

In the harsh Rocky Mountain climate of northern New Mexico, architect Jones has achieved passive-solar perfection. His series of natural-convection houses using under-floor rock beds are heated entirely by the sun; they use no fans, pumps, or blowers; and yet they maintain almost constant temperatures day and night.

Solar engineer Morris monitored the performance of the prototype house during the colder-than-normal January and February of 1981. His findings: The passive-solar heating system delivered essentially 100 percent of the heat needed for the 2,000-sq.-ft. house, and did so with a temperature swing of only 4.2 degrees F. Many thermostats don't do that well.

Now that the first of these under-floor-rock-bed houses has proved itself, refined—and less costly—versions have sprouted in the hills around Santa Fe. And Jones has plans for an entire subdivision of passive-solar homes. "We're bringing solar into the mainstream for Mr. and Mrs. Average Homebuyer," he told me.

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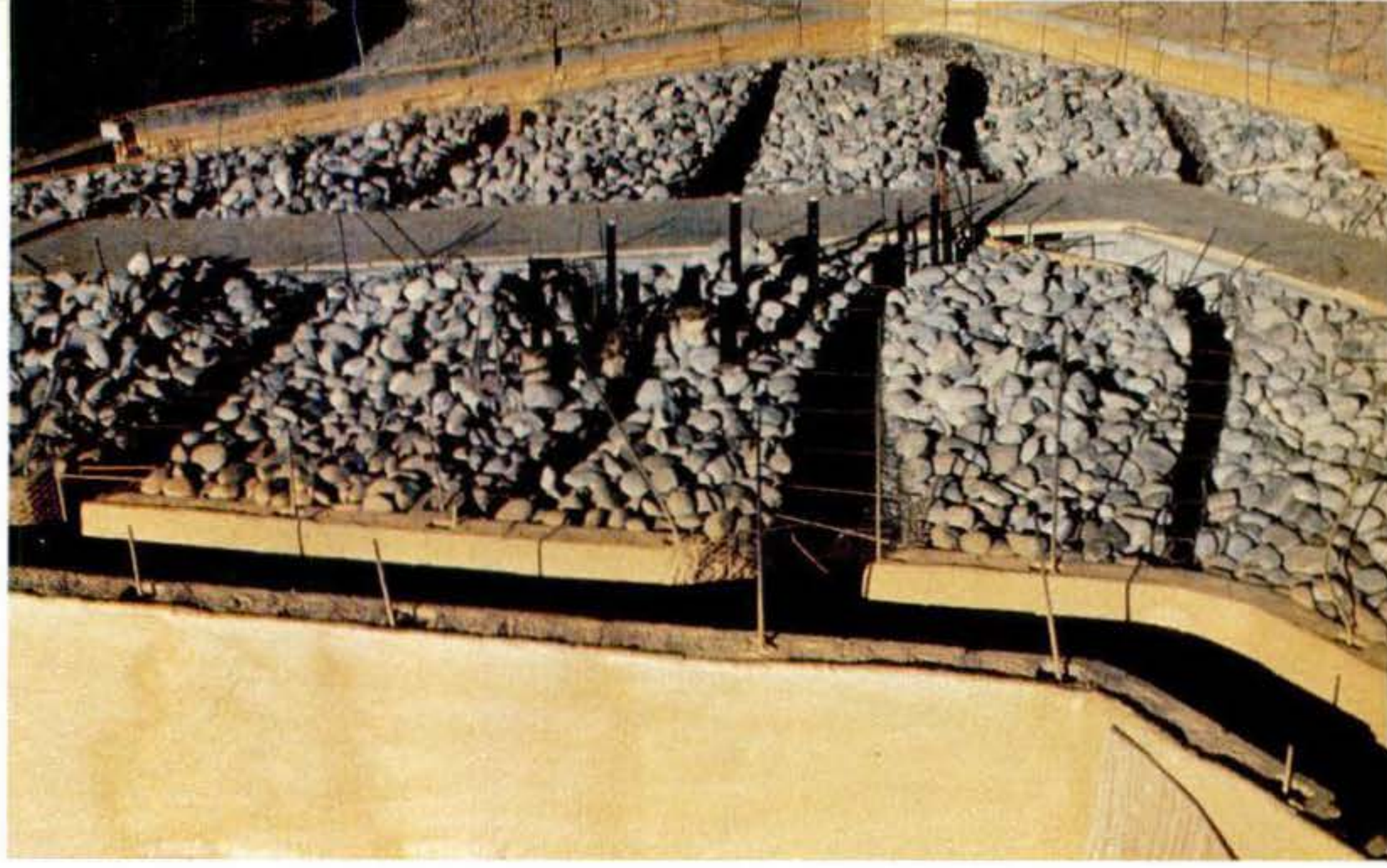
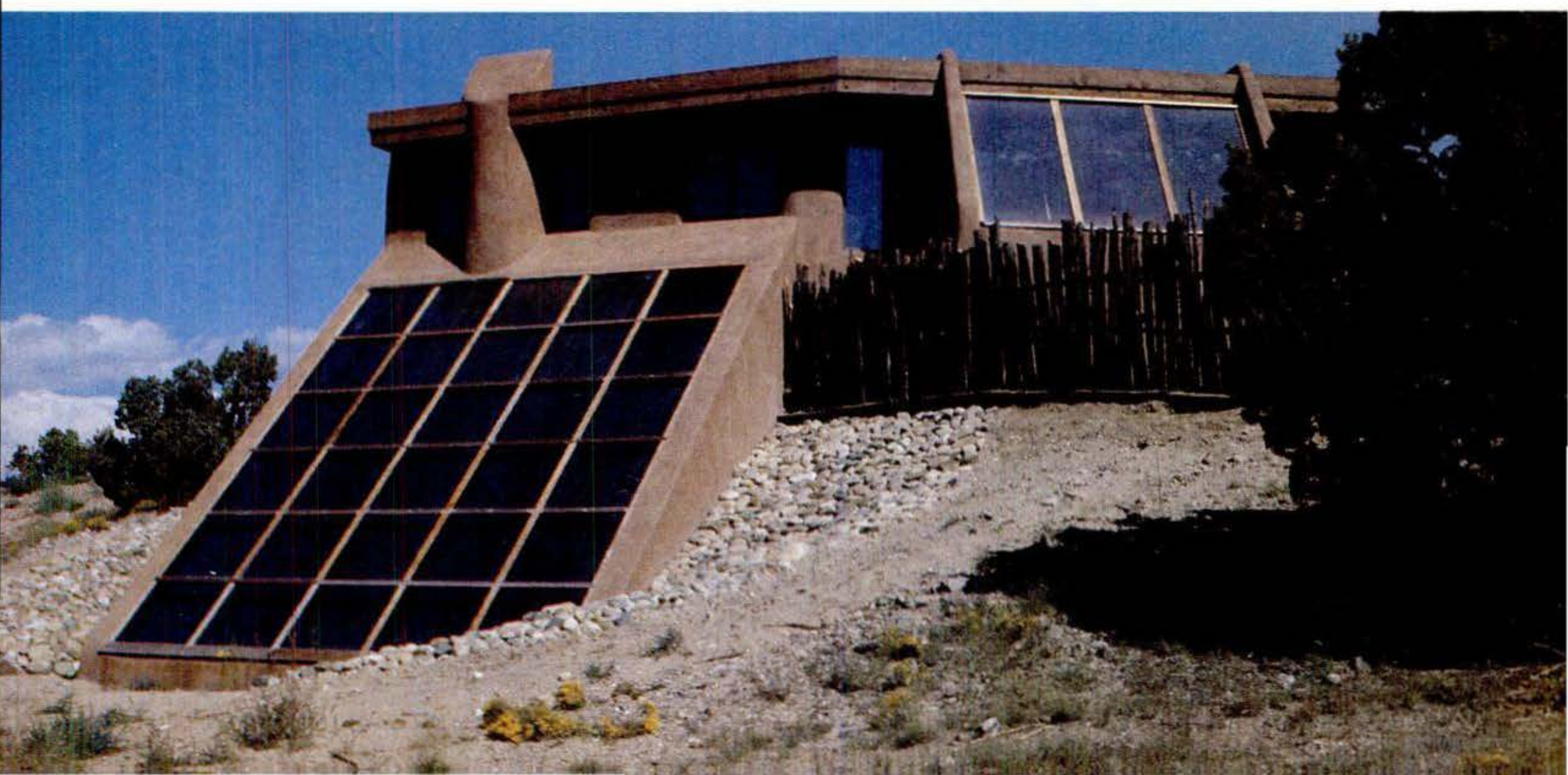
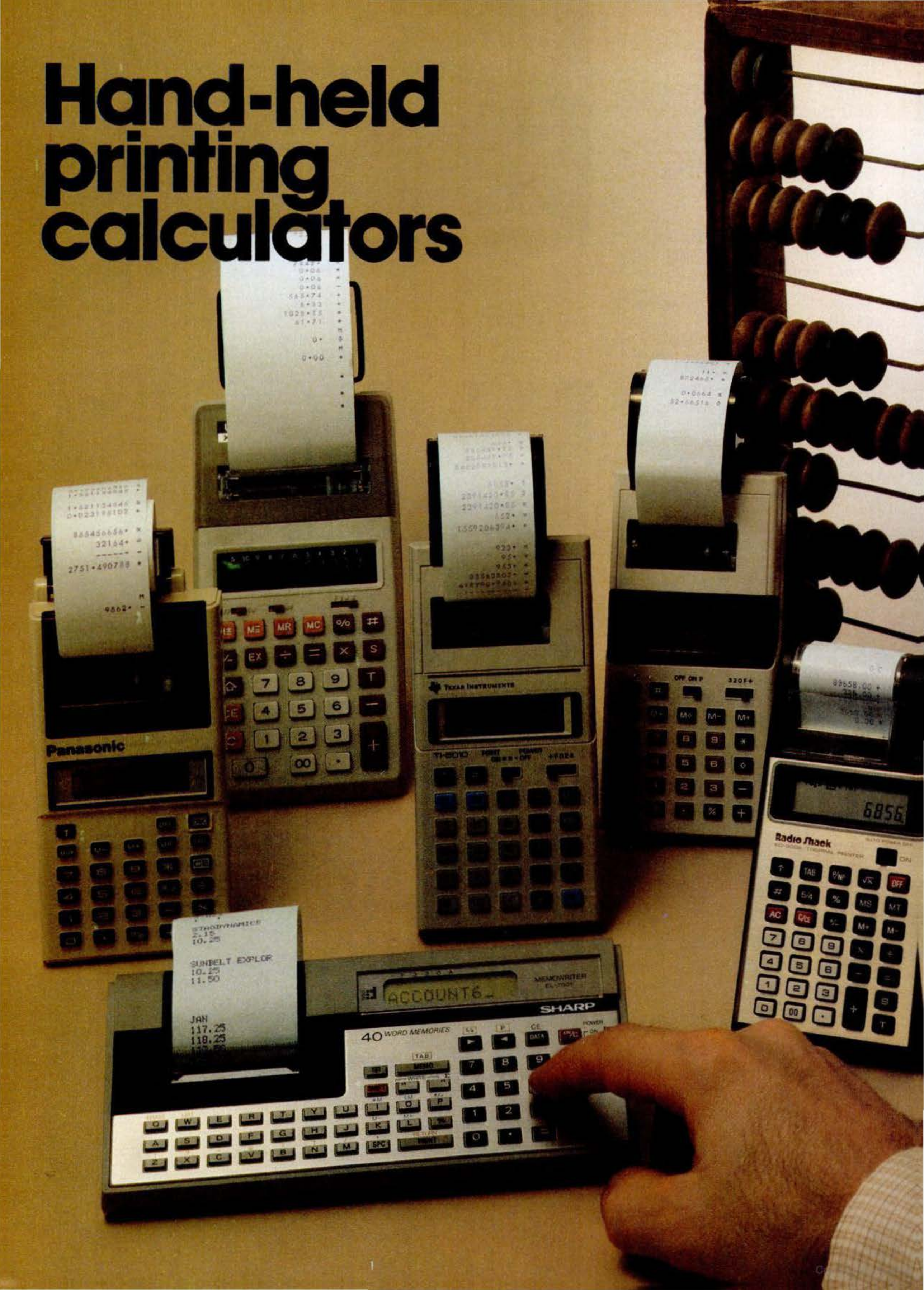


Huge number of man-hours went into laying thermal mass of rock (top). Follow-up design cut costs. House is designed in Southwest style, but walls are framed—not adobe. Fireplace is an amenity only. Siphon collector must be below rock bed (bottom), so south-hill site is needed. Stack vents collector heat in summer.



Hand-held printing calculators



Low-price models fit in your shirt pocket. Others store memos . . . some even keep track of the time and date

By JOHN FREE
PHOTO BY JOHN KEATING

They clatter like miniature typewriters, whir like tiny electric drills, and spew out lengthy messages like pocket-sized Teletype machines.

They're the newest portable print/visual calculators. And despite audible variations, they all give you a permanent record of your calculations on a narrow strip of paper.

Battery-powered printing calculators have been available for about 10 years. But many models have remained costly and relatively bulky. Now several new shirt-pocket-sized models cost less than $40. In addition, there's a widening range of calculator types: scientific, time/calendar, message-storage, financial, and more.

If you're considering a larger desk-top printer model for last-minute tax calculations, you'll probably find that a hand-held printer can serve you both at home and on the go. Printout models let you check early steps in your calculations on paper to see if you entered, say, the correct interest rate. Most non-printer models don't give you access to steps in chain calculations you might want to review.

Hand-held models I tried have different print mechanisms and built-in features. But several models from competing firms were practically identical—despite great price differences.

Sharp's $140 EL-7001 Memowriter has an alphanumeric keyboard. You can store notes in a memory that isn't erased when the power switch is shut off. Or you can mix data and comments—checkbook entries with notations, for example. The 7001 has a dot-matrix, 10-digit liquid-crystal display that scrolls to the left when it's full.

Both the Sharp model and $105 Canon FP-10 require tiny ink-ribbon cassettes. Impact printouts on plain paper are in dot-matrix form, and you change the ribbon when the print becomes too light. The Canon model has a greenish fluorescent-tube display and a full range of scientific and statistical functions.

The $103 Unisonic XL-112 has a different impact-printing mechanism. Two dime-size wheels have raised numbers or symbols and are inked by contact with a small cylinder. The wheels spin and put crisp, dark numbers—the most legible of all the techniques—on plain paper.

Three other models, the $40 Panasonic JE-610P, the $60 Toshiba LC-1028PV, and $60 Texas Instruments 5010, have this same printing mechanism. But these models are considerably smaller and lighter, and use smaller rolls of paper than the Unisonic. The compact $70 Radio Shack EC-3006 uses thermal printout on heat-sensitive paper. Casio's $70 CP-10 has its microelectronic circuits programmed for date or time at the touch of a button.

You may need a training session with the operating manual before using one of these—even if you're familiar with four-function portables. Why? Because most have special subtotal, decimal-point, and round-off keys. PS

Portable calculator models combine liquid-crystal and fluorescent electronic readouts with a variety of paper-printing systems: dot-matrix or solid-character impact on plain paper, or dot matrix on heat-sensitive paper. In the foreground is the Sharp alphanumeric EL-7001 Memowriter. Other models, left to right: the low-cost Panasonic JE-610P, Unisonic XL-112, Texas Instruments TI-5010, Toshiba LC-1028PV, Radio Shack EC-3006, Casio clock/calendar CP-10, Canon scientific/statistical FP-10.

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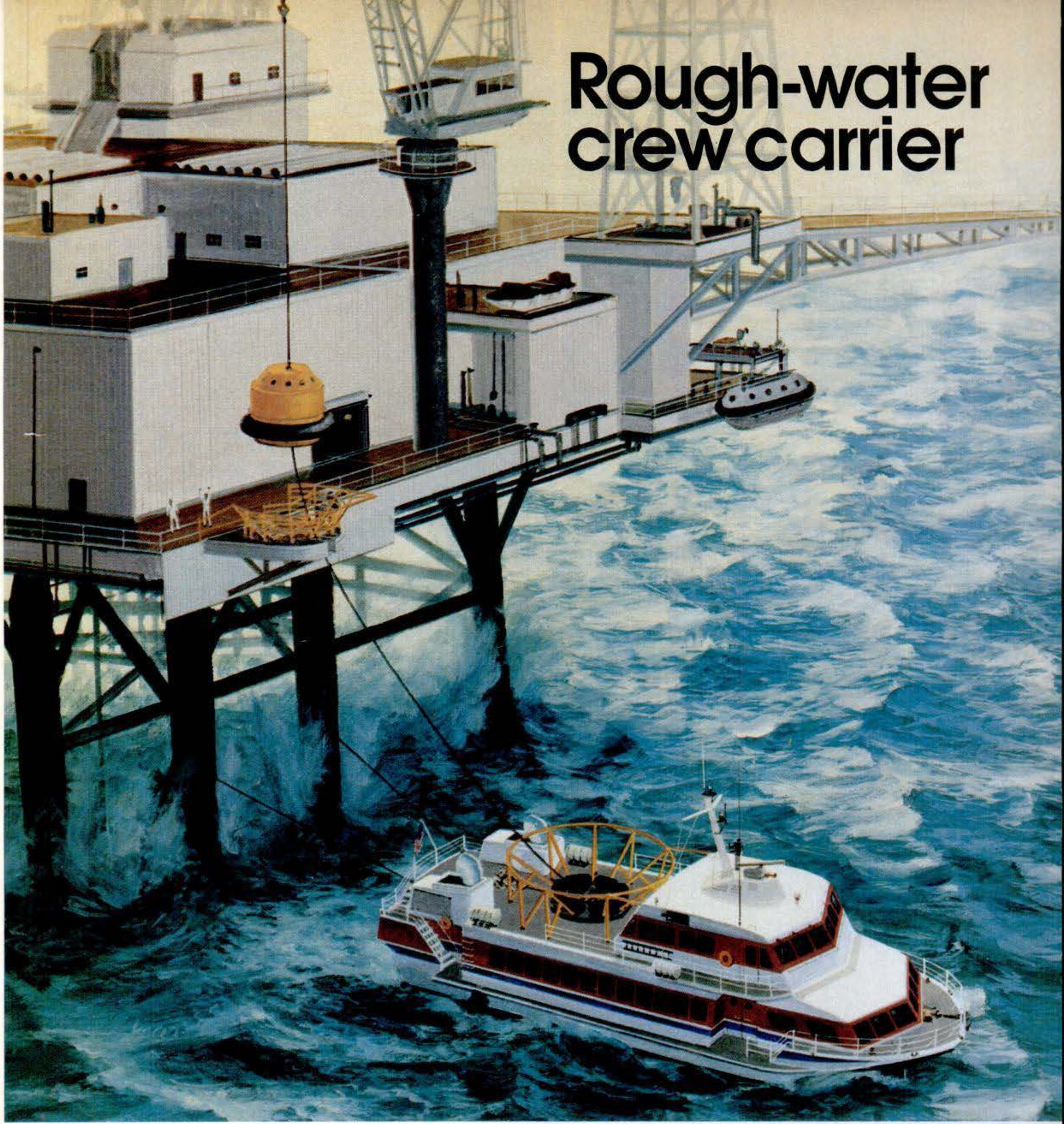

Rough-water crew carrier

It's a quick, comfortable elevator ride to the top —even in churning seas

By BEN KOCIVAR

Drilling for oil is a profitable business. Getting thousands of workers to and from offshore rigs is often just the opposite: They are paid for travel time as well as for time on the job. Conventional crew boats carry only 20 to 150 passengers, at speeds of just 15 to 25 knots. And 50-mile trips in rough seas are more conducive to delivering seasick employees than productive ones. Helicopters that fly at 130-knot speeds are the usual alternatives, but their costs per hour often exceed $1,000.

Boeing Marine Systems and Harding A. S., a Norwegian engineering firm, have been studying the possibility of using Boeing's 45-knot Jetfoils to carry up to 300 people smoothly in the choppy North Sea. However, with waves rising and falling as much as 20 feet, the actual transfer of workers from the boat to the sometimes-100-ft.-high platforms still posed a problem.

The solution to that is termed the Boeing Relative Motion System. With it, claims the company, 160 workers could be placed on and taken off the rig in just 70 minutes.

Essentially, the system consists of a vertical-lift elevator suspended by cables between a cargo crane atop the oil-rig platform and the carrier ship (see painting). Key to the concept is a "wave heave-motion compensator"—a system of uphaul and downhaul cables, which, when under tension, would allow the cab to match the heaving motion of the boat.

Boeing says the system could be used 95 percent of the time, and hopes it will be operating in 1983. PS

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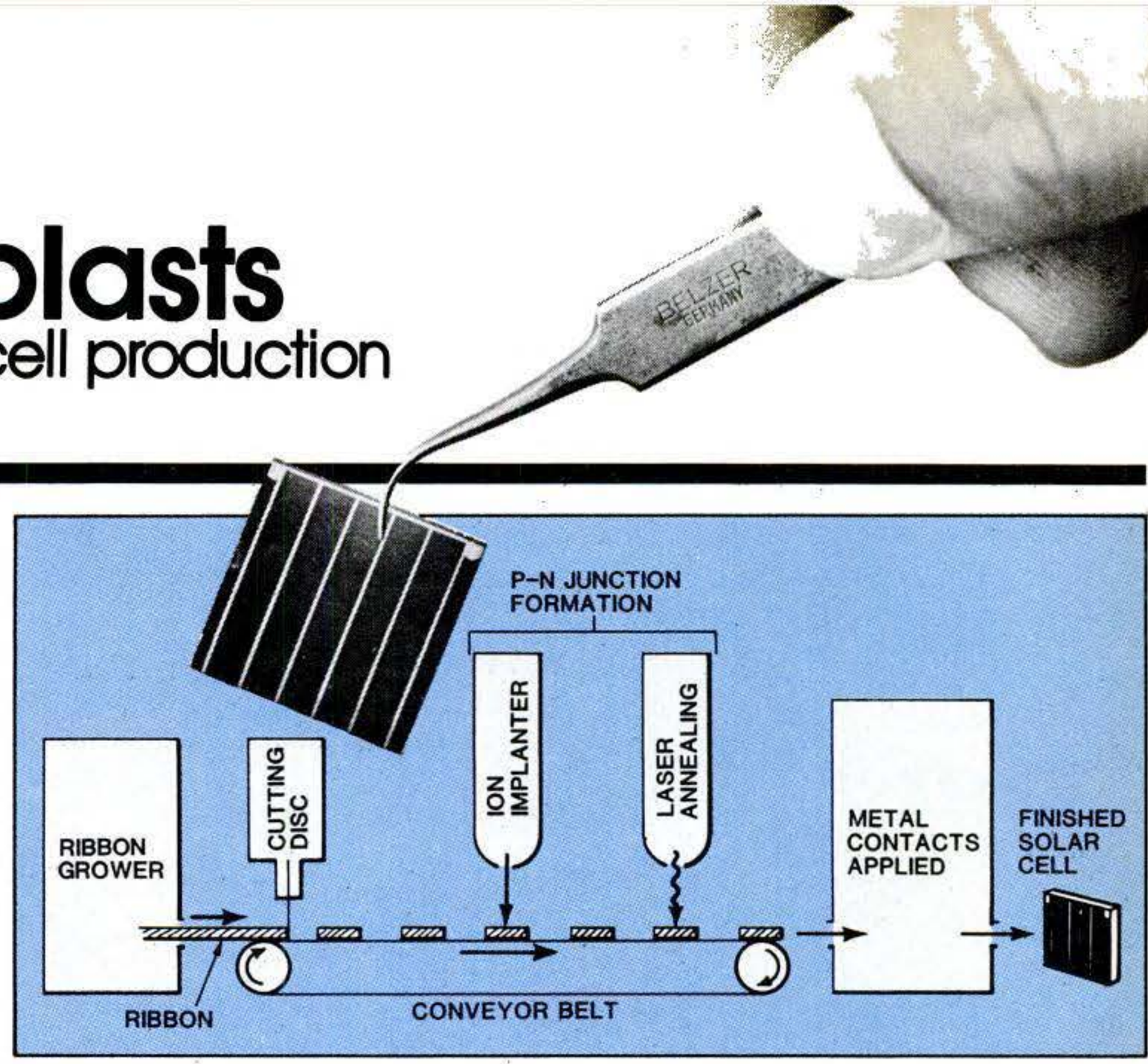
Laser blasts
speed solar-cell production



Shattered crystals in low-cost silicon are repaired by bursts of light

By DAVID SCOTT

AMSTERDAM, NETHERLANDS

"In four years, arrays of solar cells like this could be producing one watt of electricity from sunlight for 70 cents instead of $7.50," said Dr. Dick Hoonhout, picking up a postage-stamp-size square of paper-thin silicon.

Hoonhout is a researcher at Holland's Institute for Atomic and Molecular Physics here, where they're working on techniques of using cheap polycrystalline silicon. This material is often poor for solar cells, and processing makes it worse. "We're using different production techniques," he said, "ones that can be applied with conveyor-belt automation."

Hoonhout believes cheap silicon and automation could lower the price to the U.S. Department of Energy's 1986 70-cent target for solar panels—a sharp reduction over today's $7.50 per watt.

At the Amsterdam institute researchers are using a laser instead of the usual furnace after silicon is bombarded with ions during cell preparation. The technique is cheaper, faster, and avoids heating the polysilicon and thereby spoiling its crystalline structure.

Solar cells are made by "doping" the silicon surface with chemical impurities to form two different, adjacent semiconductor layers. This is the first step in creating the p-n (positive-negative) junction of materials that produces electron flow when the cell surface is illuminated.

Surface restoration

The snag is that the doping process degrades the critical surface structure of a cell. Crystal formations must be restored or the cell loses its electrical properties.

"A problem with polysilicon," Hoonhout said, "is that it cannot stand high temperature. It develops serious structural faults when heated by the diffusion process commonly used for doping. We're trying to avoid that harmful baking by ion implantation."

This technique involves blasting the silicon with phosphorus atoms accelerated by high voltage into a high-energy beam. Particles penetrate less than one micron (millionth of a meter), so the p-n junctions are very near the surface.

"That shallow depth is a further advantage of implantation over diffusion, because the short-wavelength light photons have a better chance of being absorbed," he said.

"But a disadvantage is that ion bombardment blasts the crystals to pieces," said Hoonhout. The traditional method of restoring surface crystals is baking silicon in an annealing furnace. That's practical for high-quality single-crystal silicon wafers or ribbons [PS, April '81] often used for cell production, but not for polycrystalline silicon.

Enter laser annealing, Amsterdam's big contribution to the production sequence. Hoonhout and his colleagues blast the ion-scarred silicon with a ruby laser that turns the damaged layer back into crystalline form. "It rearranges the phosphorus atoms in the right position," says Hoonhout.

"The flash is so short you don't see it," he said. "You just hear the 'ping' of exploding air." The red beam has an energy of one or two joules, pulsed to last only 25 nanoseconds (billionths of a second). But this power concentrated on the small target spot is about 60 megawatts (millions of watts).

The Amsterdam group sees an automated production line starting with a ribbon grower. Squares cut from the slow-growing ribbon would move beneath the ion implanter and laser-annealing gun, which together form the p-n junctions (see diagram). Metal connectors are next added to complete the cells, which are then ready for assembly into panels.

Low-resistance contacts

Good electrical connections with cells are essential to tap solar energy, so the group is also studying another problem: making low-resistance contacts between metal strips and semiconductive silicon, but providing gradual transition of electrical resistance. That is needed for a smooth current flow that boosts power output from the cells.

Greater contact area between metal and silicon boosts energy collection, but the opaque metal also screens the cell surface beneath it from sunlight.

A fine-tuned compromise is necessary to optimize the balance between maximum and minimum coverage. On the institute's experimental cells, this is done with a grid of thin metallic lines that divide the silicon square into parallel bands. Terminals are at two corners. At present, the line pattern is made by metal evaporation and deposition.

Philips in Holland is now working on screen printing, an alternative process adapted from textile technology. It's faster and cheaper, and could improve current collection from polysilicon cells. This could be another important step in bringing the Amsterdam solar cells closer to low-cost mass production. PS

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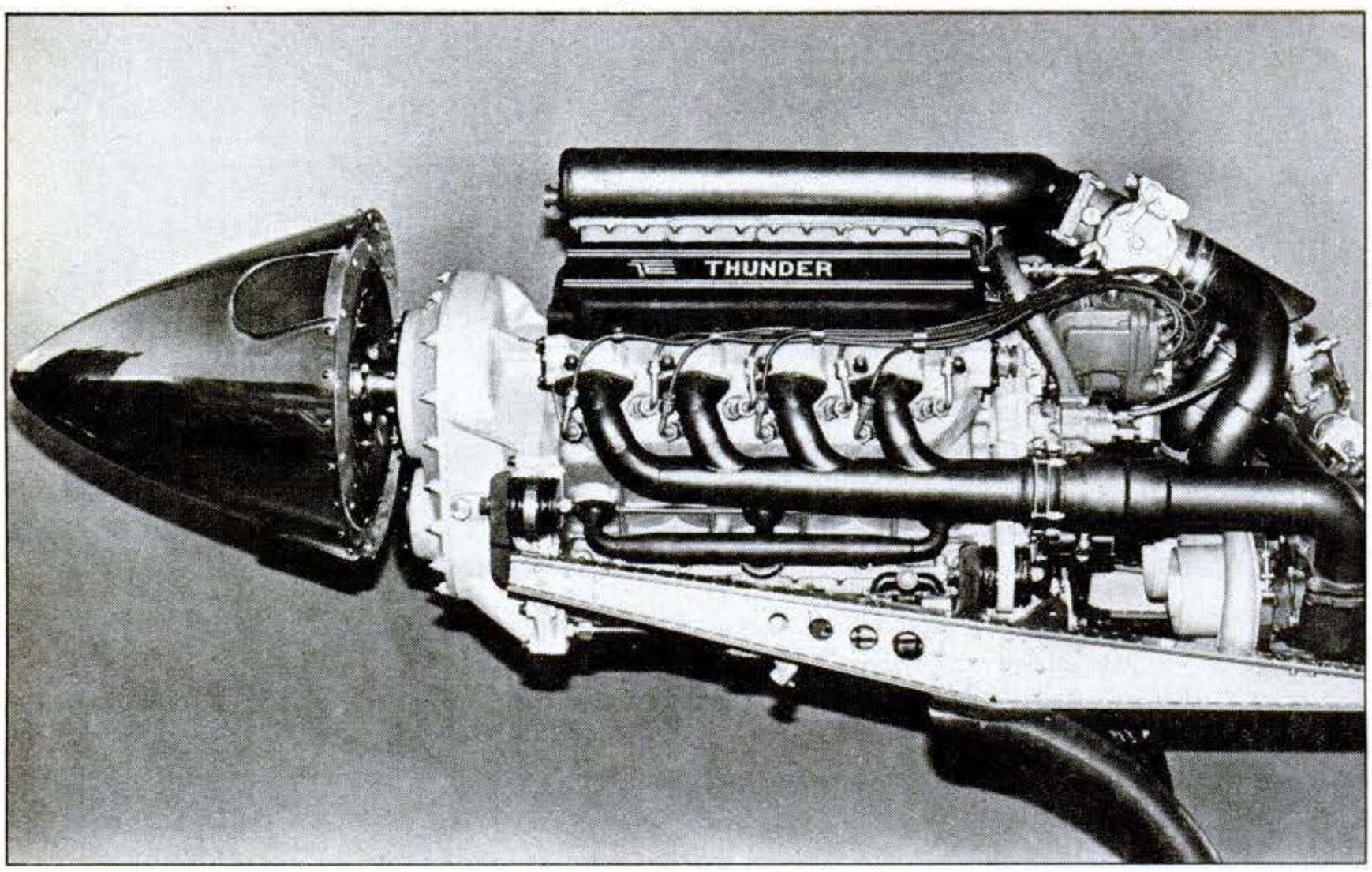
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Aircraft V8

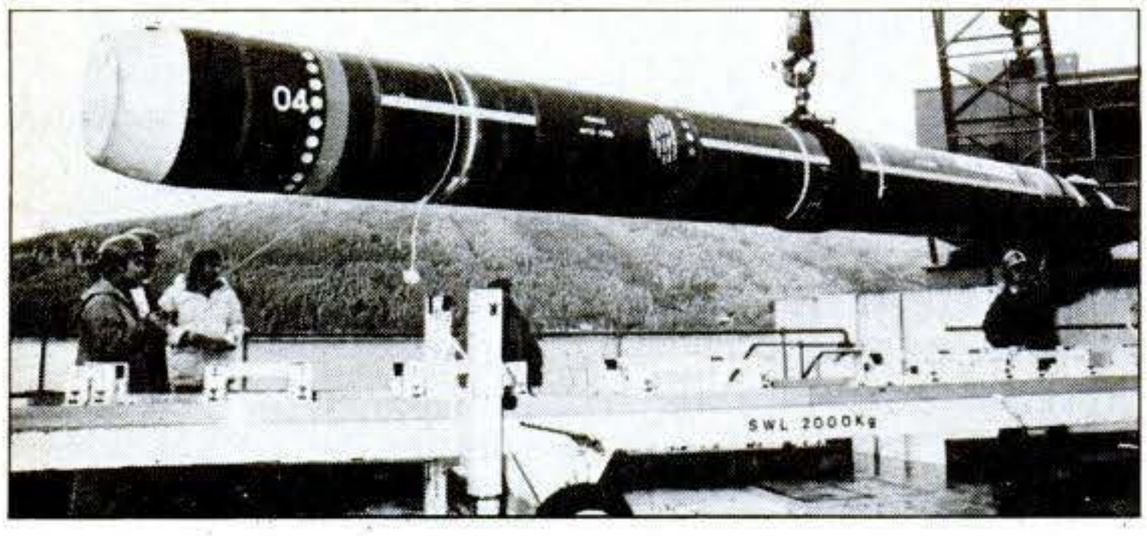
Thunder engine is a modified V8 originally developed for road racing. Now the supercharged, 700-hp, aluminum-alloy motor is being certified by the FAA for aircraft use. The compact shape simplifies streamlining, and Thunder Engines, Inc. (Van Nuys, Calif.), claims good fuel economy.

Ear protector

For hazardous work areas that are noisy, too, Bilsom's Comfort muff attaches to safety caps with a screw-on connector. The ear protectors can be flipped up during quiet periods. Price: $15.60. Bilsom International, Inc., 11800 Sunrise Valley Dr., Reston, Va. 22091.

Lightweight cast

Ever been weighed down by a plaster cast? Scotchcast tape has one-third the weight of plaster but is four times stronger, says 3M. Knitted fiberglass holds a resin that hardens when exposed to water. The tape lets skin breathe, but wearers can bathe.



80-knot torpedo

A torpedo designed to chase and destroy the fastest nuclear submarines is prepared for trials off the Scottish coast. The computer-guided weapon is about 28 feet long, weighs two tons. Top speed for the deep-diving torpedo: 80 knots. It's made by Marconi in England.

Rotor ring

Helicopter tail rotors are noisy and dangerous to ground personnel. Bell Helicopter Textron (Ft. Worth, Tex.) is testing a ring fin on its five-seat 206B. The flat tail-rotor ring cuts noise, improves performance. And the chopper can now fly sideways over 50 mph.

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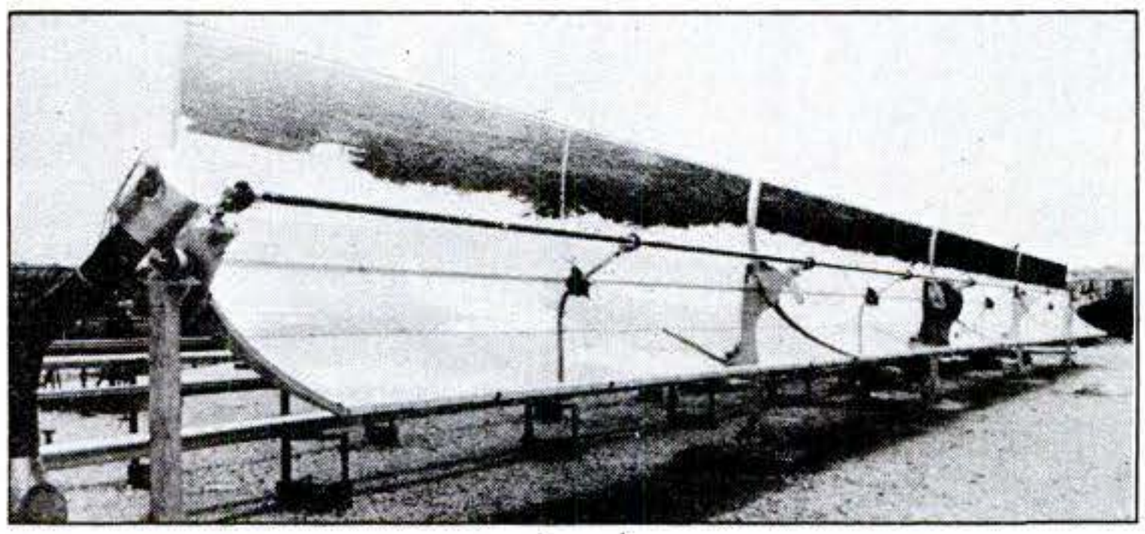
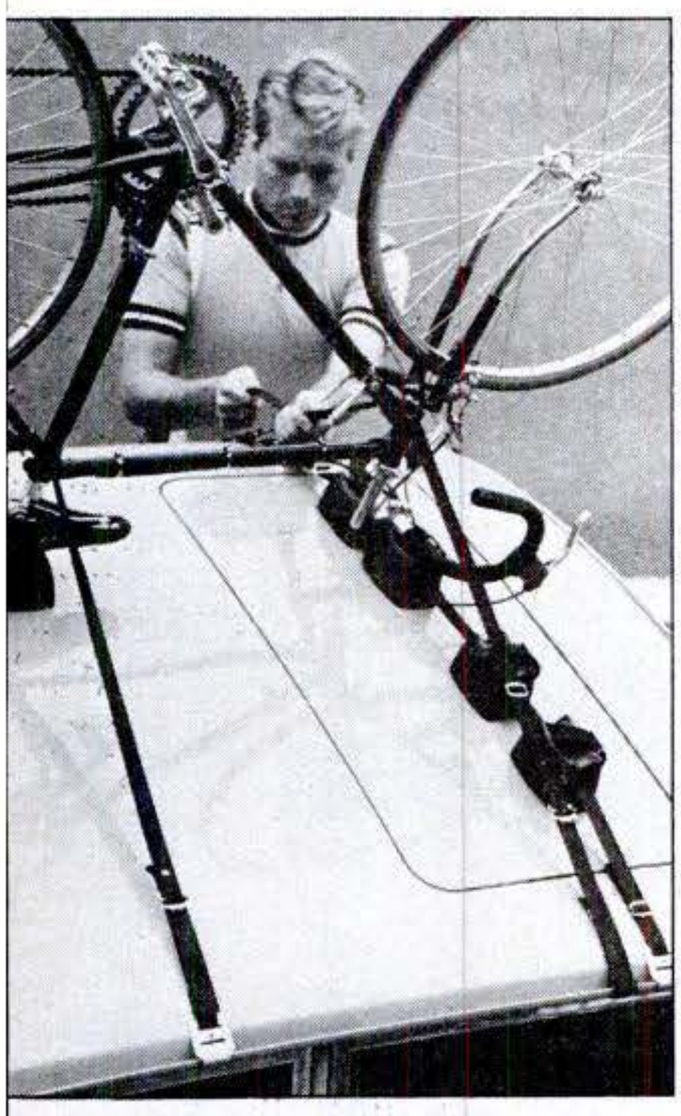
Jumbo drain

A 30-ton aluminum culvert, claimed by Kaiser Aluminum to be the biggest in the world, was installed at a planned community in Dade County, Fla. The 214-ft.-long drain is elliptically shaped, with a 34-ft. span. It enables a creek to flow with a two-lane road over it.



Solar steam

Textile plants will trim costs of producing steam with fossil fuels by using solar power, says Luz International (Los Angeles, Calif.). Luz is building collector systems, each requiring the area of eight football fields, for three major Southern textile firms.



Bike rack

You can roll up a Zulu bike rack and stow it in your car trunk. Setup time? About four minutes, says the maker (Cyclesports, Inc., Box 18937, Seattle, Wash., 98118). Zulu comes with no-scratch plastic cradles, straps, gutter clamps, and storage bag; costs $40.

Patrol ship

A ship with a 10,000-mile range and 20-knot top speed has been added to the British navy. HMS Leeds Castle, first of a new patrol-vessel class, can be adapted as a missile-armed gunboat or as an anti-sub ship. The 265-ft., twin-screw vessel carries a crew of 50.

High-fiber biscuits

Missing fiber in your diet? FiberMed is a biscuit made with corn, wheat, and oats. Two biscuits provide 120 calories and 10 grams of dietary fiber—equivalent to fiber in 88 slices of white bread, says The Purdue Frederick Co. (Norwalk, Conn.). It can be bought in drugstores.

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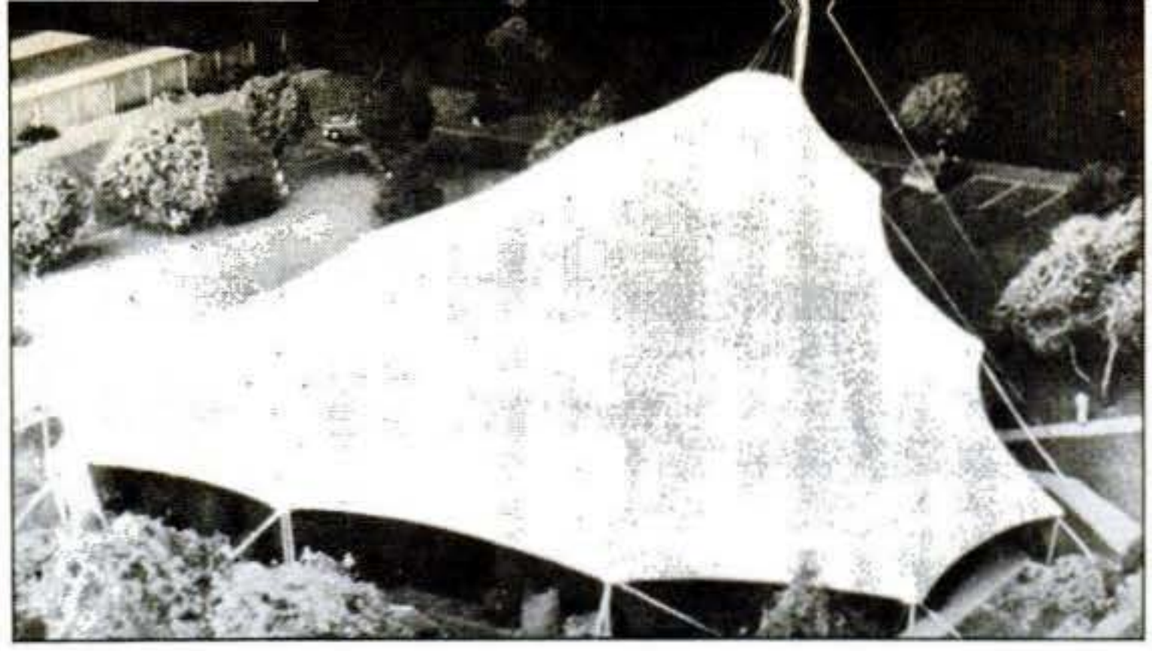
What's New

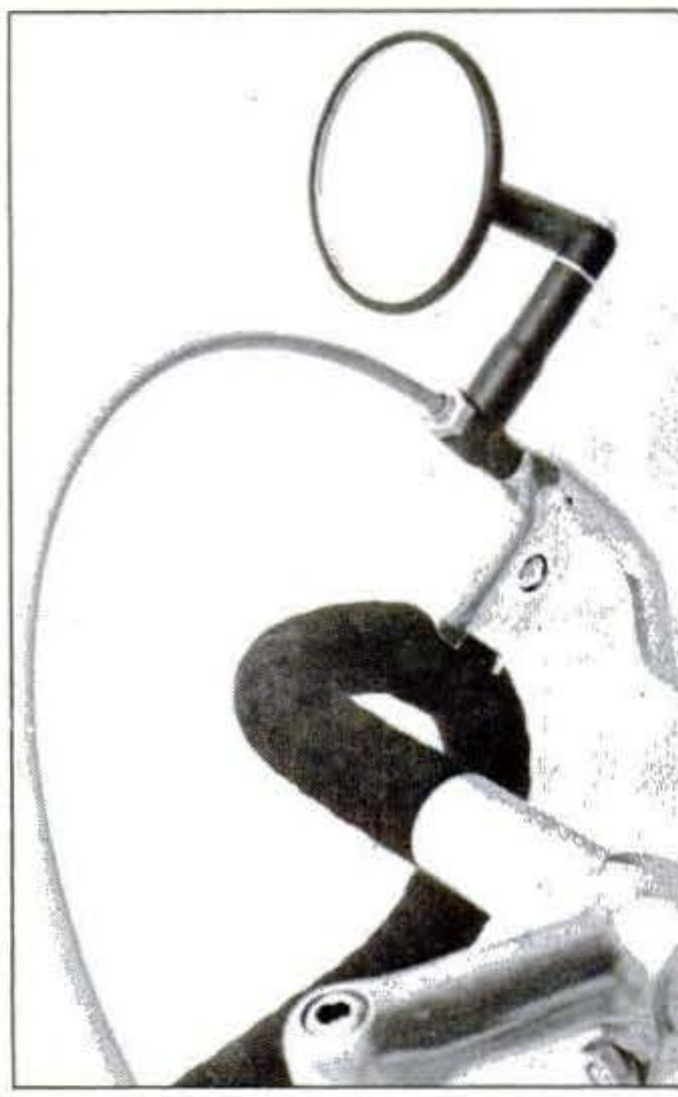


Cloth church

The first permanent tent pitched down under, St. Anne's Church in Seaford, Australia, evokes the Biblical Ark of the Covenant. But the cable-tensioned fiberglass membrane was computer-designed to sustain 70-mph winds. Birdair (Box 476, North Bennington, Vt. 05257) built the tent.

Low-rise pumper

At 6½ ft. high, the Low Rider fire truck is short enough to scoot under low-clearance entrances at airports and hotels. But the squat truck has full-size firefighting apparatus, including a 50-gal. foam tank for fighting plane and auto fires. Grumman (Melville, N.Y. 11747) makes it.



Traffic tracker

Designed for racing-style handlebars, this wide-angle bike mirror bolts to the brake-lever bracket. It's safer than handlebar-mounted mirrors that obstruct a rider's grip, says Mirrycle (Box 2157, Boulder, Colo. 80306). If hit, the $9 mirror's polycarbonate frame folds up.

Stretchable trailer

A pop-up roof gives the 12-ft. Sprite Compact six ft. of inside headroom. Two gas-assisted toggle jacks lift the roof easily, says CI Caravans (Fordham Rd., Suffolk CB8 7AL, England). The collapsed roof cuts drag so small cars can tow the trailer.

Gas sipper

Cruising at a steady 38 mph, this miserly Mini Metro goes 120 miles on a gallon of gas. The modified engine has a special plasma ignition system that easily ignites an air-rich fuel mix. Butterfly Motors (Redditch, Worcester, England) modified the Leyland auto.

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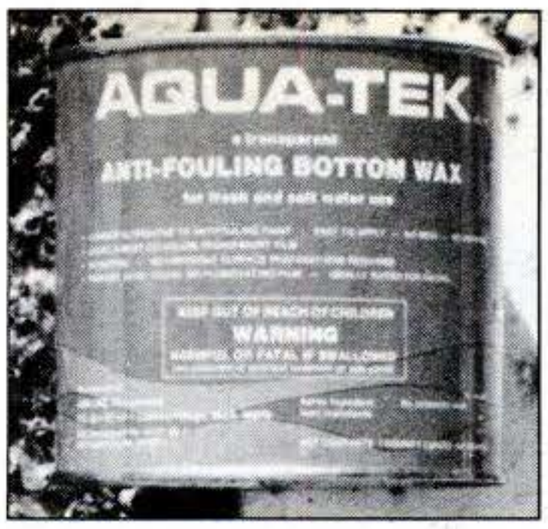
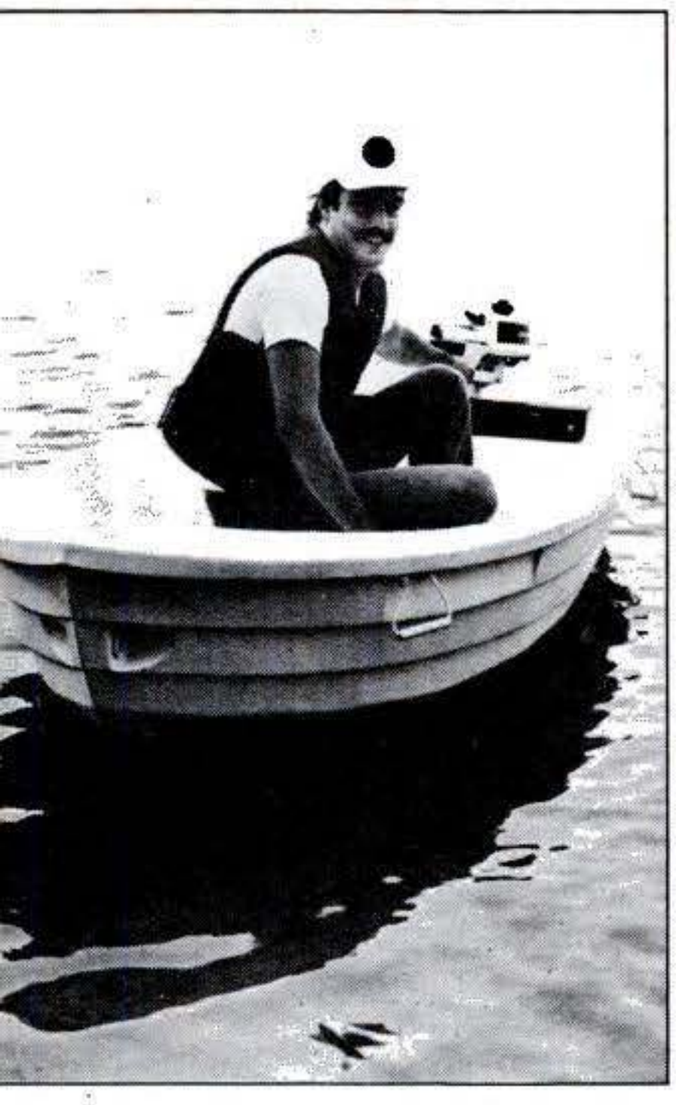
What's New IN BOATING

BY SUSAN RENNER-SMITH



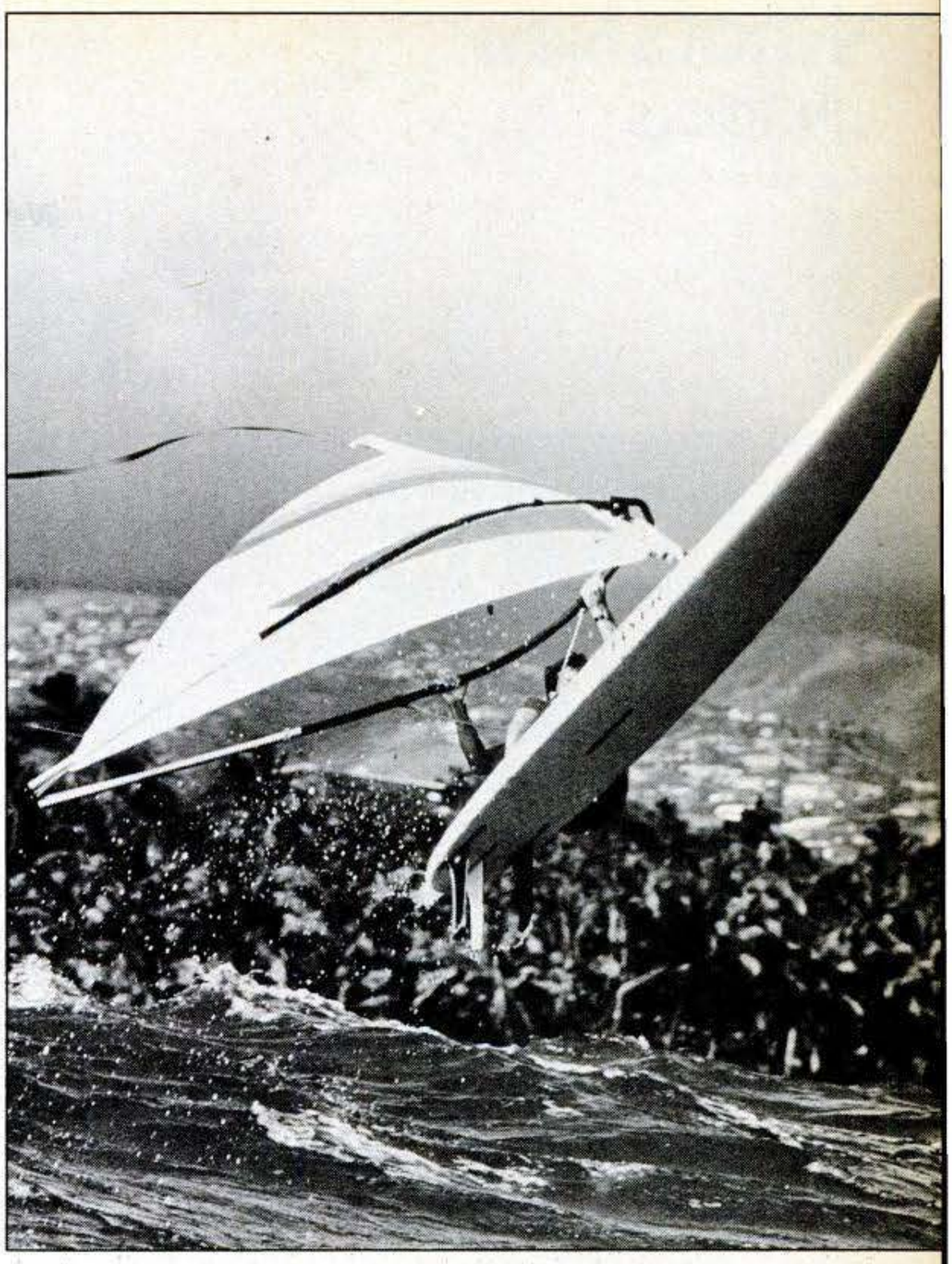
Barnacle fighter

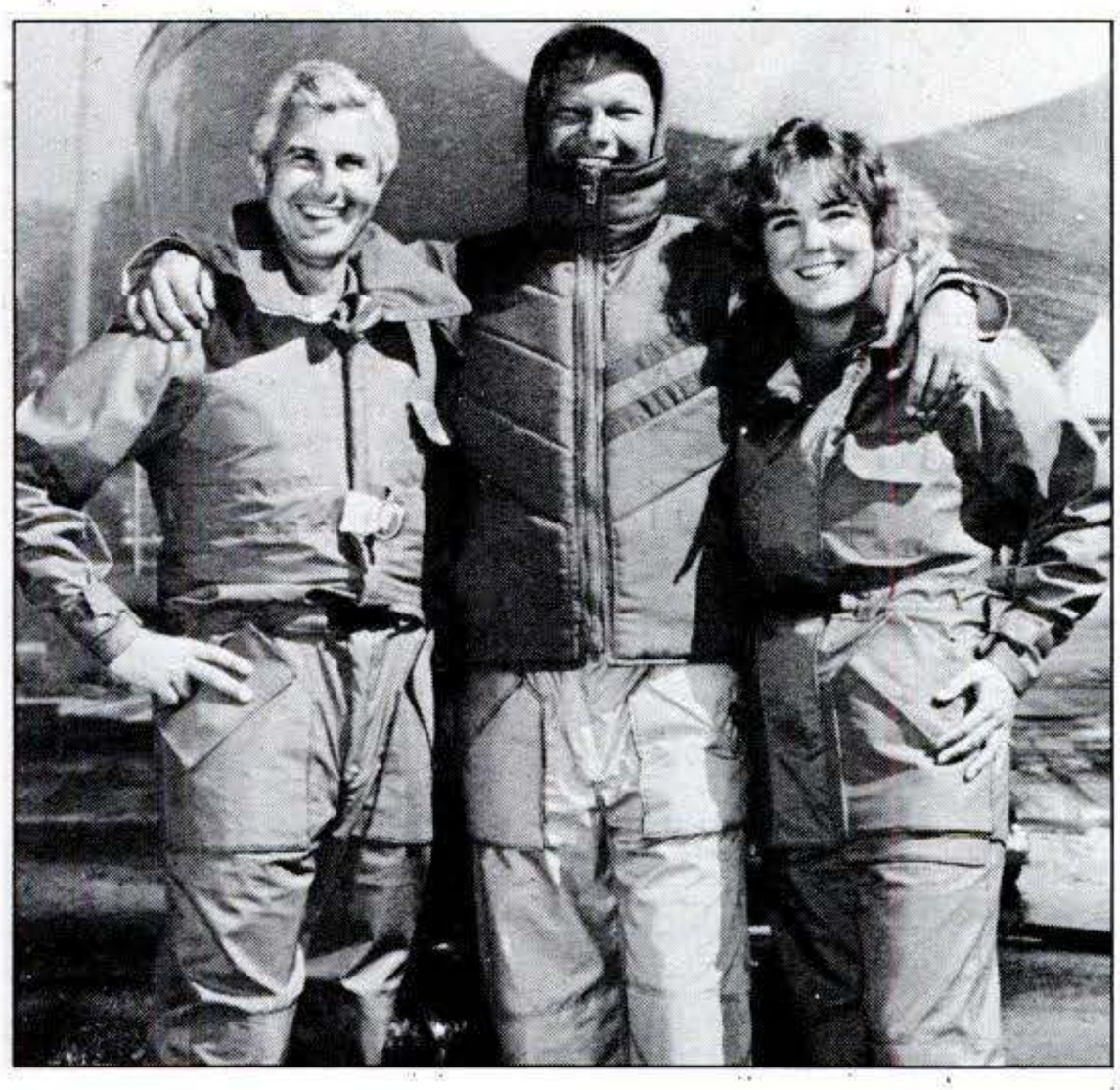
Protection without painting—that's the promise of new Aqua-Tek. A waxlike polymer resin, it keeps underwater surfaces from fouling for a full season, claims American Chemical Corp. (1115 Hamilton Ct., Menlo Park, Calif. 94025). A 1.5-lb. can covers 125 sq. ft., costs $45.



Unsinkable dinghy

Built-in handles make the 75-lb. Polywog extra portable. An air-trapping double hull makes the boat practically unsinkable, according to O'Brien International (14615 N.E. 91st St., Redmond, Wash. 98052). The eight-ft.-long, 45-in.-wide craft can ride atop small cars, yet it handles a 365-lb. load. $295.





Surf sailers

Rocketing over waves requires a smooth bottom, so the Phase II Flyer (above) has no daggerboard. Instead, the foam-filled fiberglass craft has three stern-mounted, fin-like skegs. The rounded tail of the 10-ft.-five-in. board gives greater maneuverability, says Howmar Boats (983 New Durham Rd., Edison, N.J. 08817). Price: $1,089. The Twinsurfer inflatable sailboard (right) isn't for wave-jumping—but it does sail faster than most rigid boards, claims maker (Henshaw Marine, Verrington Lodge, Wincanton, Somerset, England). The 55-lb. sailboard's marine-plywood deck is hinged to form a carrying case for the rest of the craft.

Leak-proof gear

Rain-forest testing proved the watertightness of this Incredibly Foul Weather Gear, says North Sails (305 Sniffens La., Stratford, Conn. 06497). For safety, both Blue Water (left) and Gore-Tex versions have reflective collars and cuffs. $230 to $340.

Echo bouncer

Mount it 13 feet above the water and it should bounce back a radar echo from any spot within a five mile radius. Unlike three-cornered reflectors, the multi-fold Firdell Blipper has no blind spots, claims maker. $170 from J. S. Haft, 8925 N. Tennyson Dr., Milwaukee, Wis. 53217.

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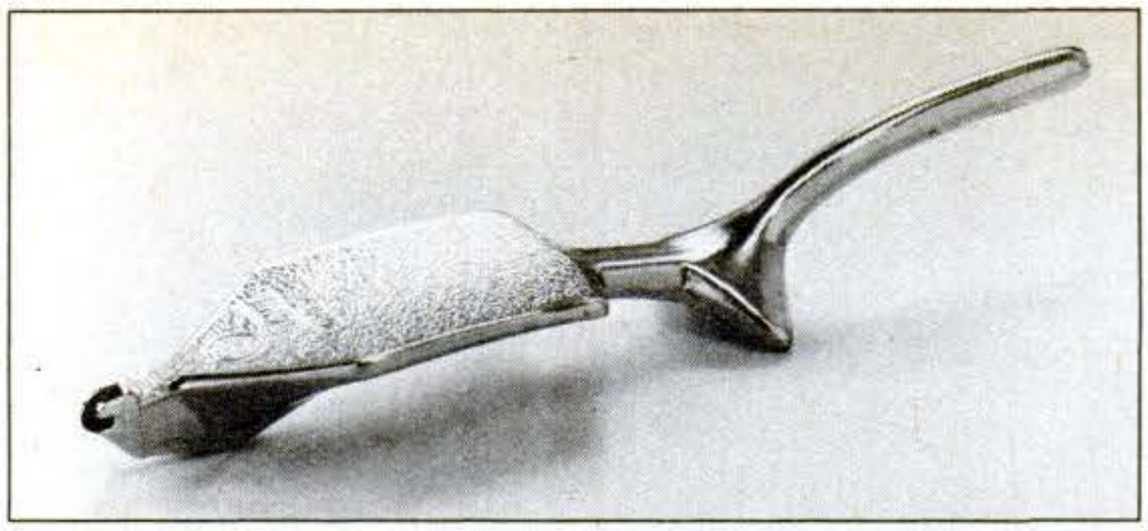
What's New IN TOOLS

BY V. ELAINE SMAY



Glass cutter

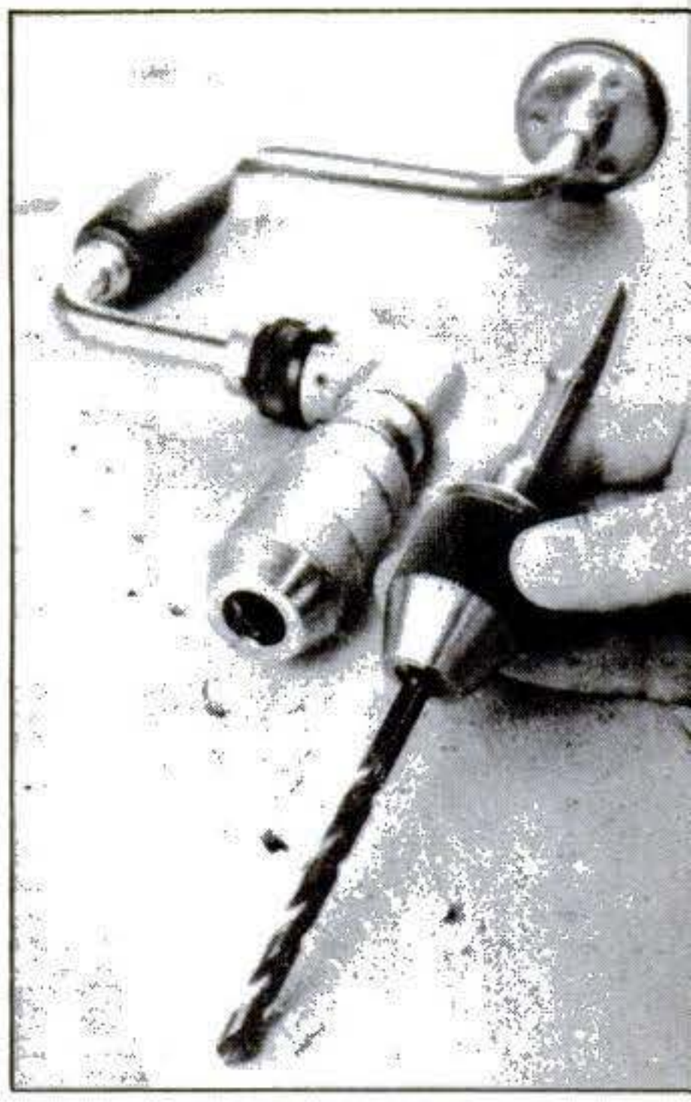
You can cut stained glass, Pyrex, plate glass, and other types of glass with the MasterCutter, says Red Devil. Five carbide replacement wheels, each designed for specific glass types, can be used on the tool. It's contoured to fit your hand for best control. Price: $13.

Hushed mower

Here's a lawn mower that doesn't assault your ears—or your neighbor's. The Solo 581 has a remarkably low (63-dBA) noise rating because its five-hp, two-cycle engine is completely enclosed. Solo Inc., Box 5030, 5100 Chestnut Ave., Newport News, Va. 23605; $400.

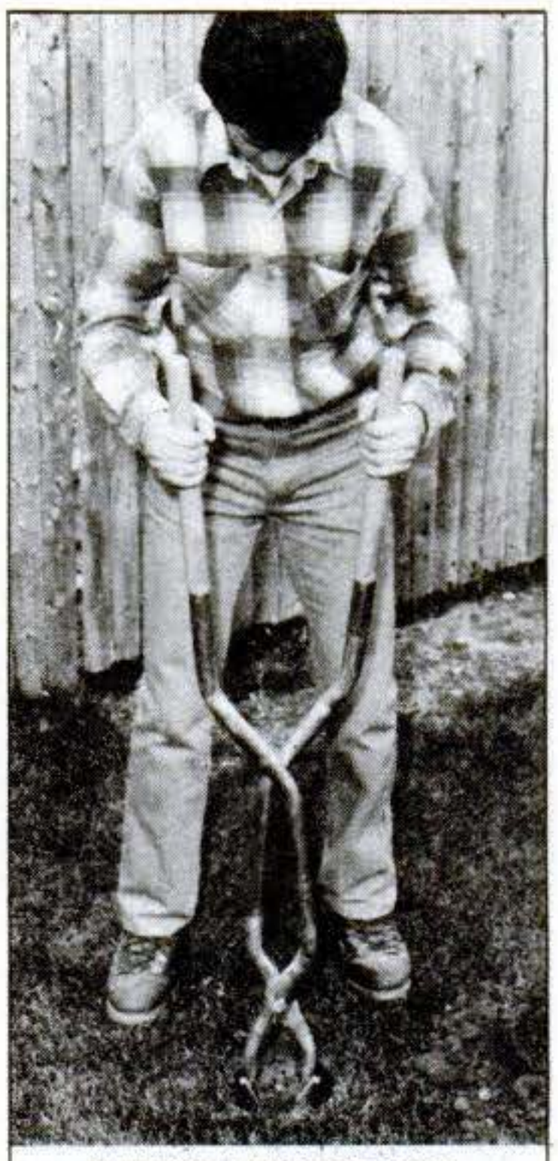
Brace adapter

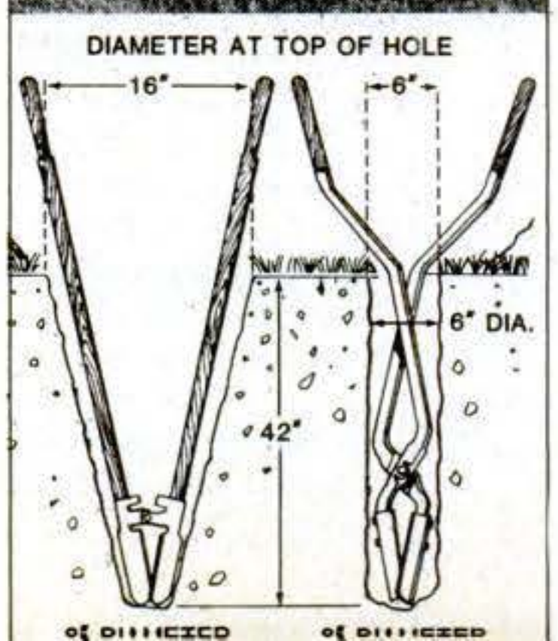
You can use round-shank drill bits in your brace with the Brace Converter ($16.95 from Garrett Wade Co., 161 Ave. of the Americas, New York, N.Y. 10013). The tapered square end goes into the brace; the other end, a three-jaw chuck, holds the bit.



Folding barrow

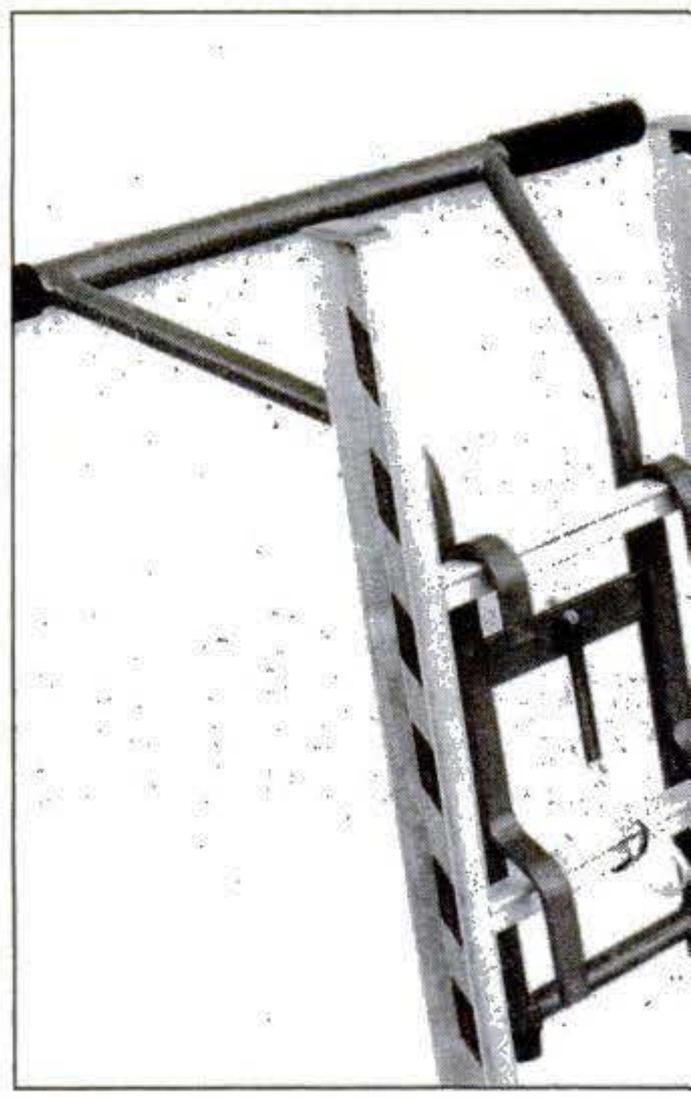
This 3½-cu.-ft.-capacity wheelbarrow folds to an eight-in. width. The bottom can be replaced with a screen or grass-seed/fertilizer spreader (optional). Haul-n-Hide is $54 (ppd.) from City Metal Products, 505 S. Fisher Rd., McHenry, Ill. 60050.





Clever digger

Dig a hole up to 42 inches deep that's only six inches wide—top to bottom. The double-scissor design of the Can-Do Digger (750 N. Milford Rd., Highland, Mich. 48031) means you remove less dirt than with a standard digger (diagram). Homeowner's model is $35; pro's, $75.



Ladder stabilizer

Clip this stabilizer bar over the top rungs of your ladder for greater reach with added safety. The wide bar with nonslip rubber tips also holds the ladder clear of rain gutters. Schneider Ladders UK Ltd., 28 Breakfield, Ullswater Crescent, Coulsdon, Surrey CR3 2HS, England.

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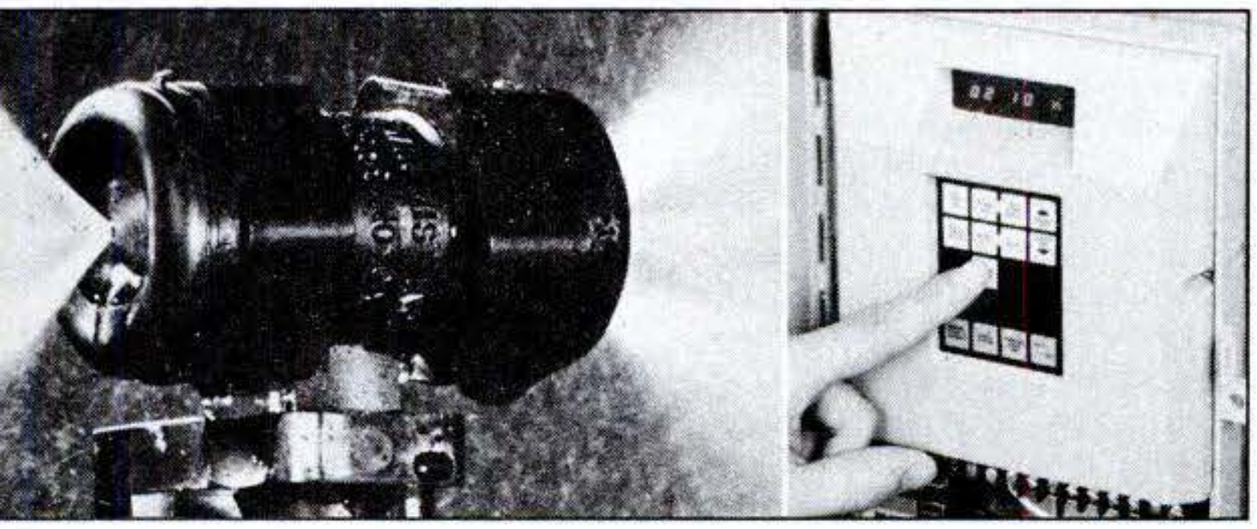
What's New IN HOME IMPROVEMENT

BY SUSAN RENNER-SMITH

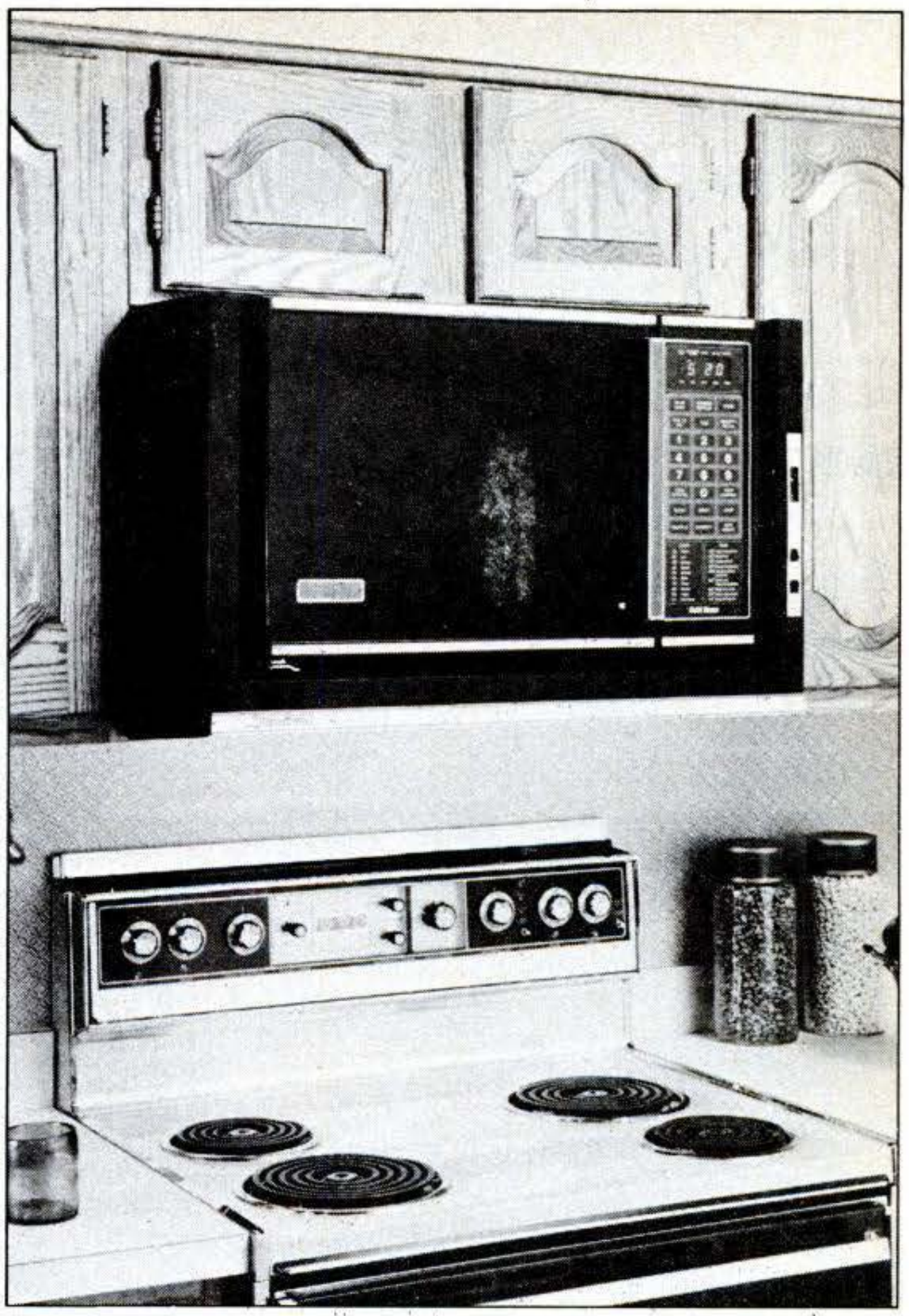
Counter clearer

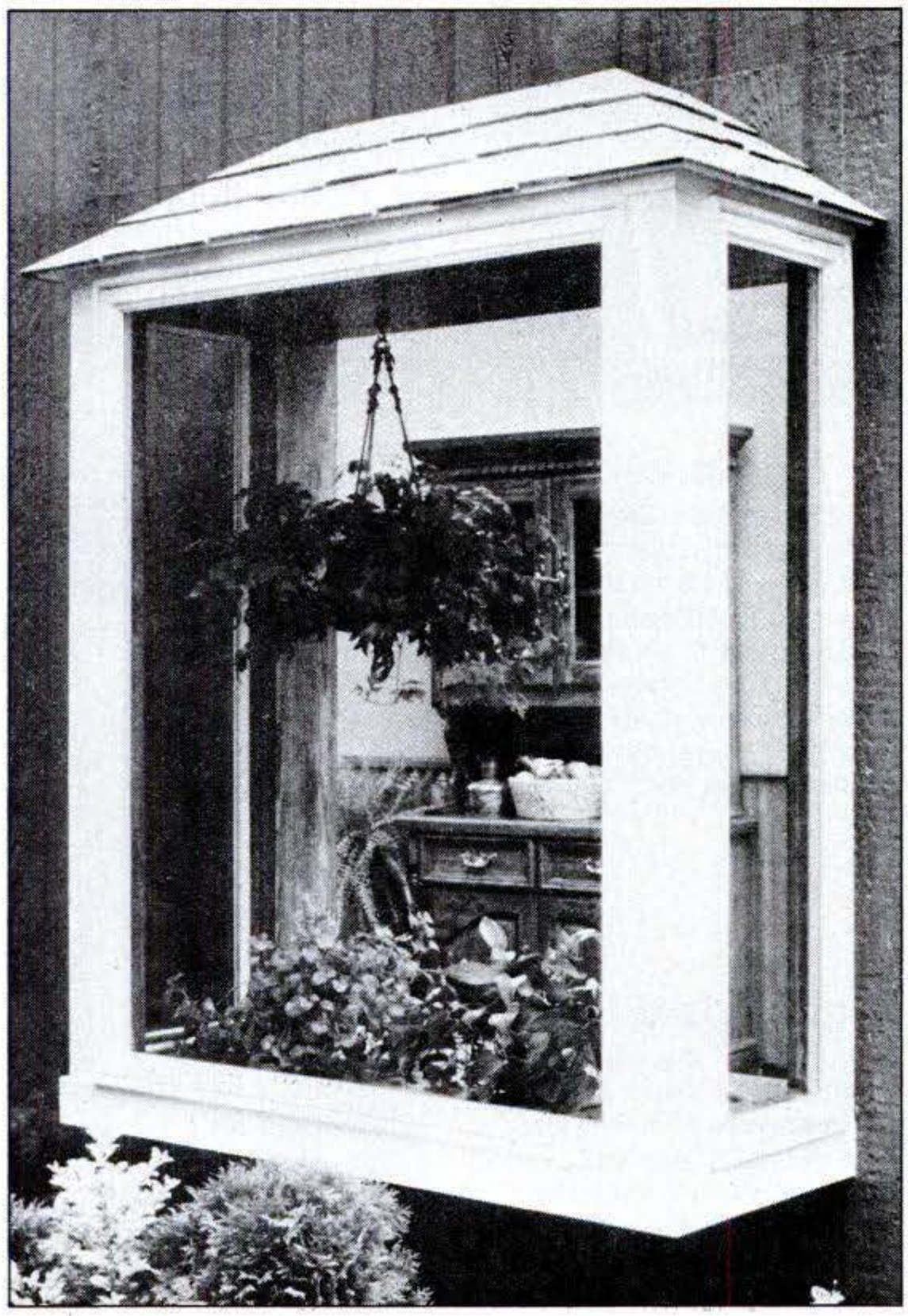
You can move your microwave off the counter—and get a ventilating hood as a bonus. The Micromate range hood is a sturdy, oven-sized shelf with built-in light and fan. Cabinet doors hide vents in the ducted version shown. Broan Mfg. Co. (Hartford, Wis. 53027) makes it. $260.



Energy-saving sprinklers

The Siamese sprinkler (left) mists as much ground as four standard heads, says Misti Maid (Box 4607, Mountain View, Calif. 94040). The rugged nylon mister aims spray vertically or horizontally. It also does water-saving drip irrigation. The mister is featured in new Misti Maid sprinkler kits (about $30). Another water saver, the Rain Clock computer timer, keeps sprinklers from running overtime. The timer automatically regulates—and repeats—a 14-day cycle. Rain Bird, 145 N. Grand Ave., Glendora, Calif. 91740: $135.





Bay view

A new nook for plants—a box bay window—opens up a room. Like Andersen's 30- and 45-deg. bays, this 90-deg. replacement unit is made of double-pane insulating casement windows with vinyl sheathing. Sizes: three to five ft. high and four to six ft. wide.

Gas light

A wireless light for your back yard, the Patio Lite uses a 14.1-oz. LP-gas cylinder. The base pole adjusts from three to six ft. The lamp has built-in ignition, and its flame won't attract insects, says Arkla (Box 534, Evansville, Ind. 47704). It costs $80.

Easy cleaner

An oil-based stain that cleans up with water. Impossible? Cuprinol's chemically modified linseed-oil base *is* soluble in water—when it's wet. Once dry, the oil won't redissolve, so the stain fully protects the wood, claims Darworth Co. (Avon, Conn. 06001). $19.

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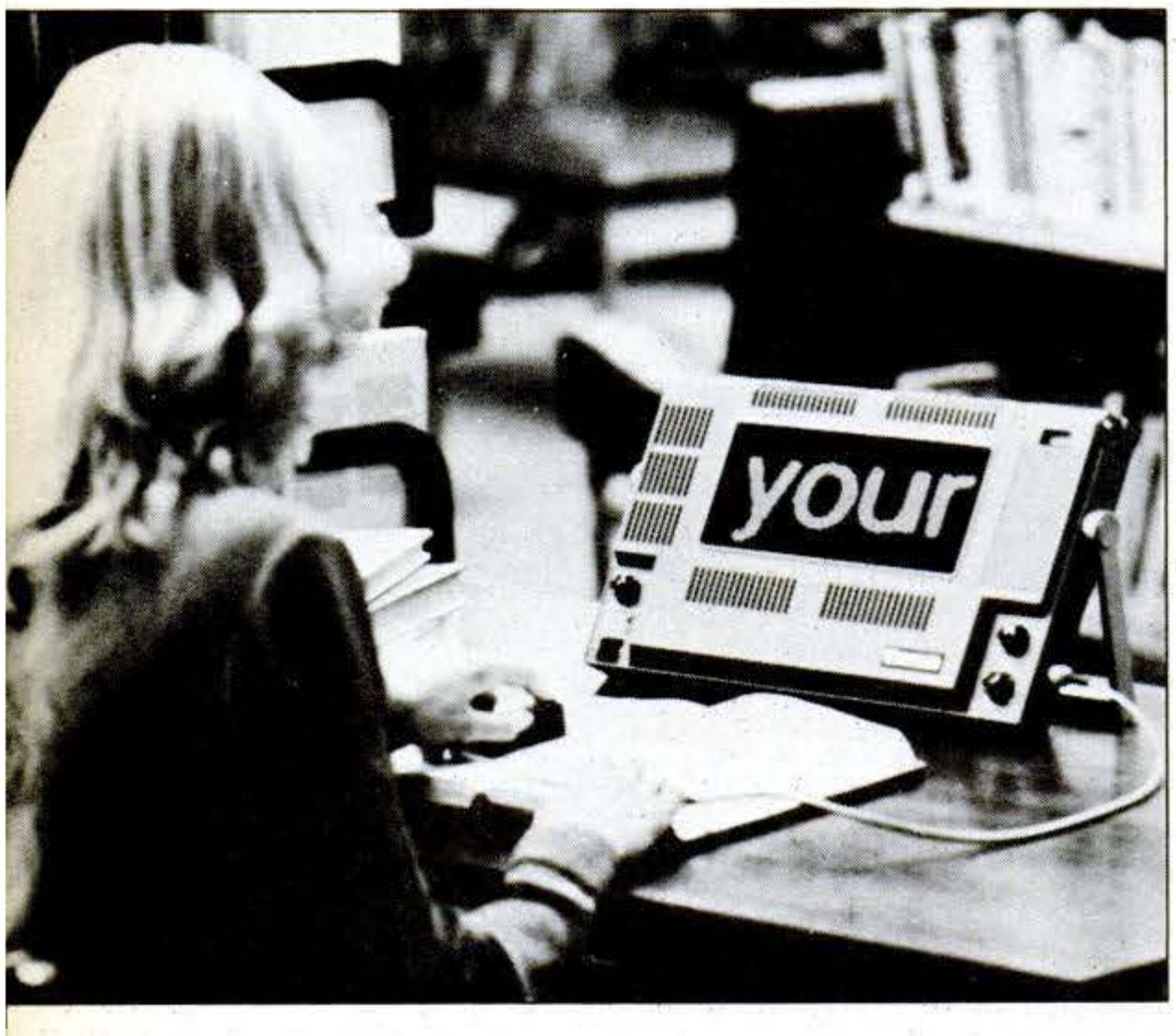
What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS

Warp fixer

All turntables are flat to lower wow, flutter, and rumble. But unfortunately, all plastic records are slightly warped. The fix: Luxman's PD-300 player with a disc stabilizer, a vacuum pump that sucks the record tightly to the turntable's surface. Price: $1,000.

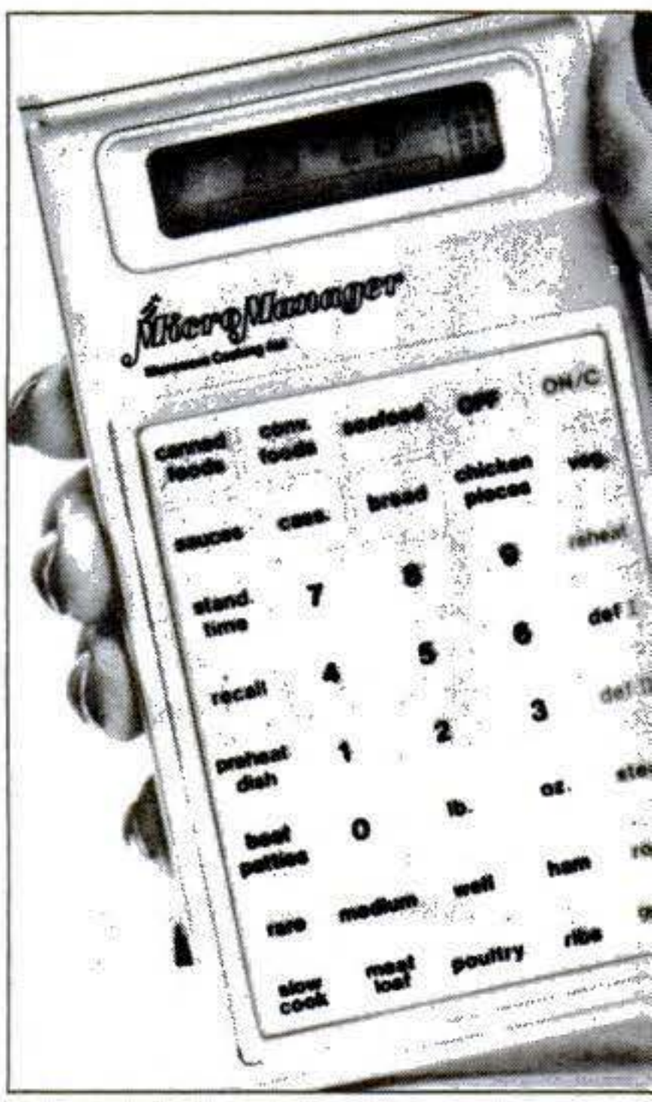


Sight helper

Viewscan is a portable, 9½-pound electronic visual aid for partially sighted people. It uses a fiber-optic camera and two microprocessors to reproduce print at 64 times its original size. It's $3,300. Sensory Aids, Ste. 110, 205 W. Grand Ave., Bensenville, Ill. 60106.

Micro timer

Ah, the speedy microwave oven. In a flash it can ruin your roast or snafu the soufflé. The cure: Enter the type of food and its weight on this MicroManager from Micro Cooking Aides (Box 64240, Lubbock, Tex. 79464). It displays the exact cooking time required. Price: $50.



Multi-bander

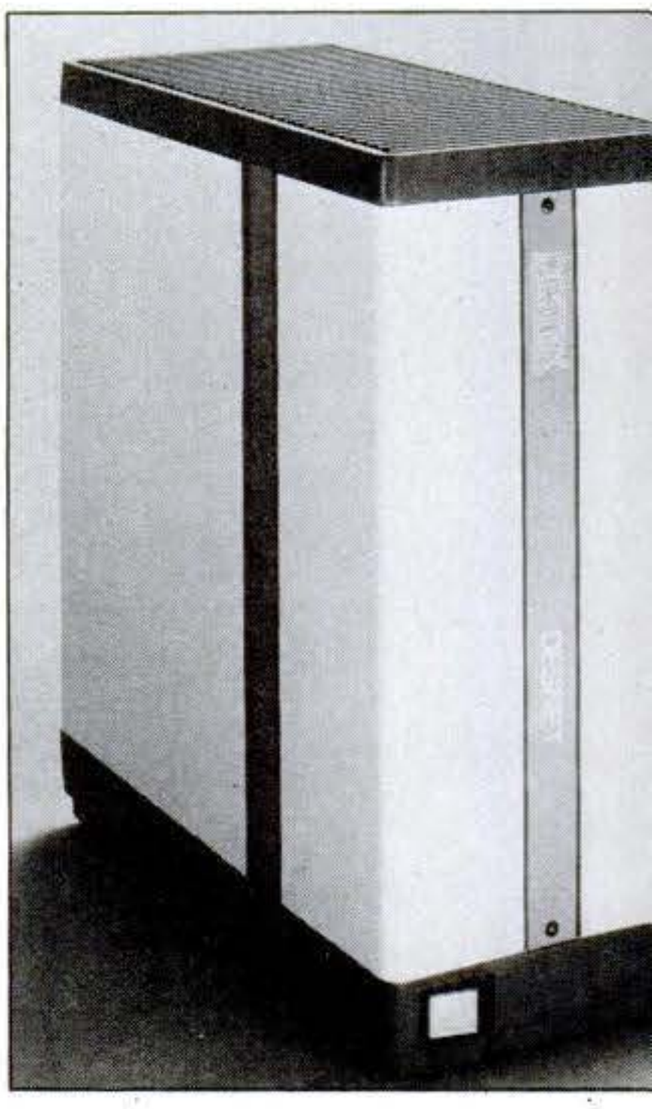
Good morning. Or is it? You'll find out fast with GE's new digital clock radio: It wakes you to the National Weather Service band or to your favorite morning TV news show (sound only). All channels, plus AM or FM broadcasts, are available on the $74 Model 7-4687.

Don't-panic button

In an emergency, push the buttons on the command console or the ones on the wireless transmitter—the Guardex system calls a specially monitored telephone number and you get help fast. It's $800 plus $15 monthly from Guardian, 31117 W. Via Colinas, Westlake Village, Calif. 91362.

Computer linker

Desnet from Destek (1923 Landings Dr., Mountain View, Calif. 94043) enables up to nine totally different personal computers to work together as a single network system. Only a standard serial or parallel peripheral connection is needed on each computer. Price: $2,295.



Digital discs

Digital audio discs (DAD) are another step closer to the store shelves: Pioneer's version will be available in Japan next year. It uses laser light to play a digitally coded record for near-perfect reproduction.

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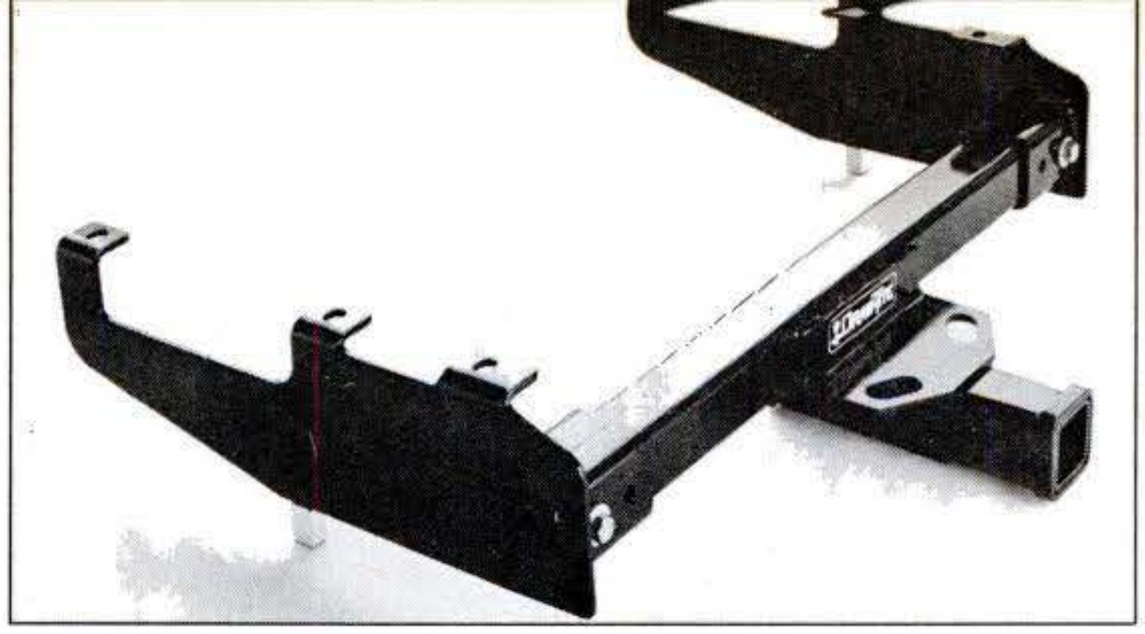
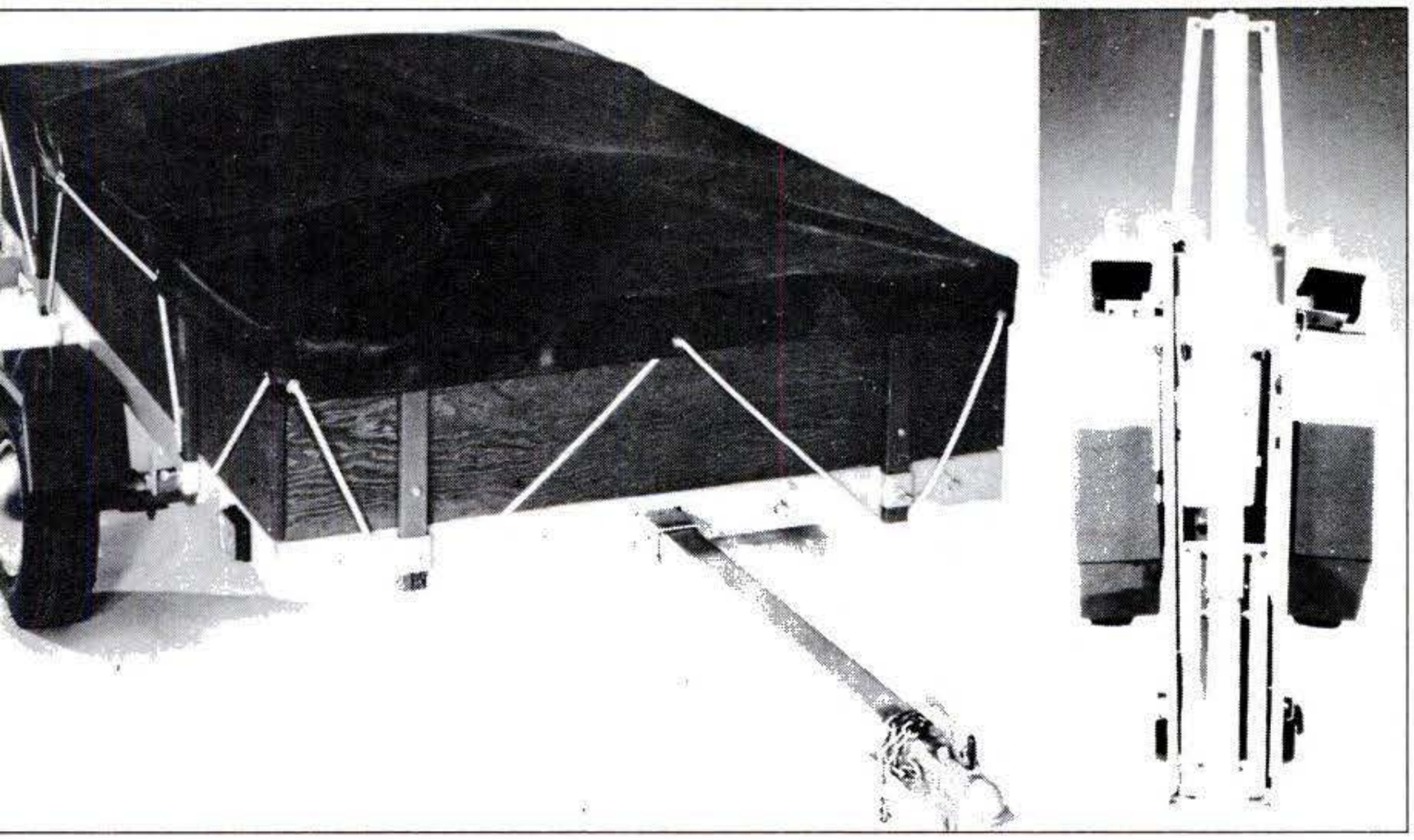
What's New
FOR YOUR CAR

BY ED JACOBS



Universal hitch

The MP005 bolt-together DIY trailer-hitch kit fits pickups and 4×4's. Draw-Tite, Inc. (14857 Martinsville Rd., Belleville, Mich. 48111), says the kit's three reversible flanges and telescoping section allow it to fit most models. Price: $156.10.

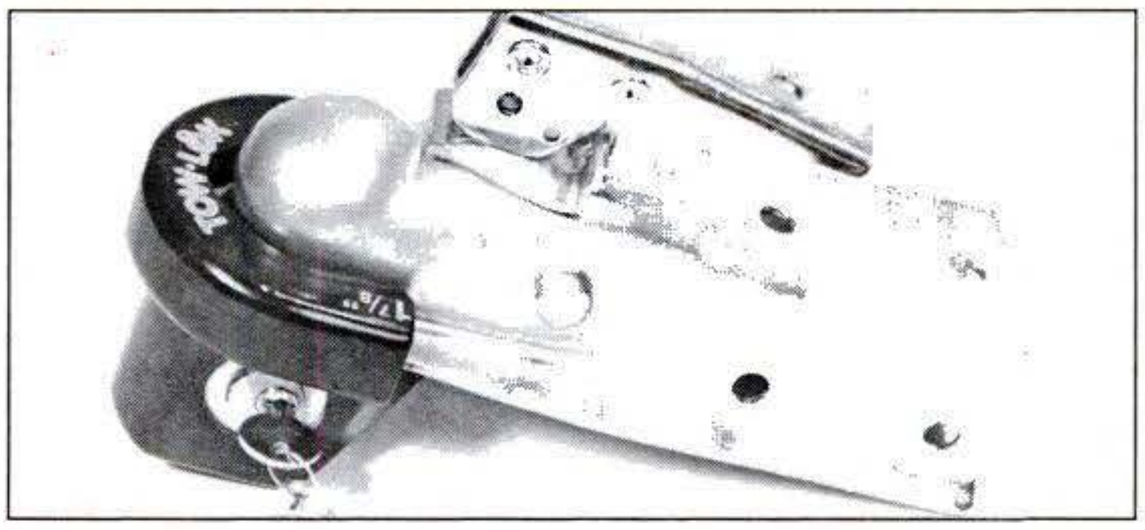


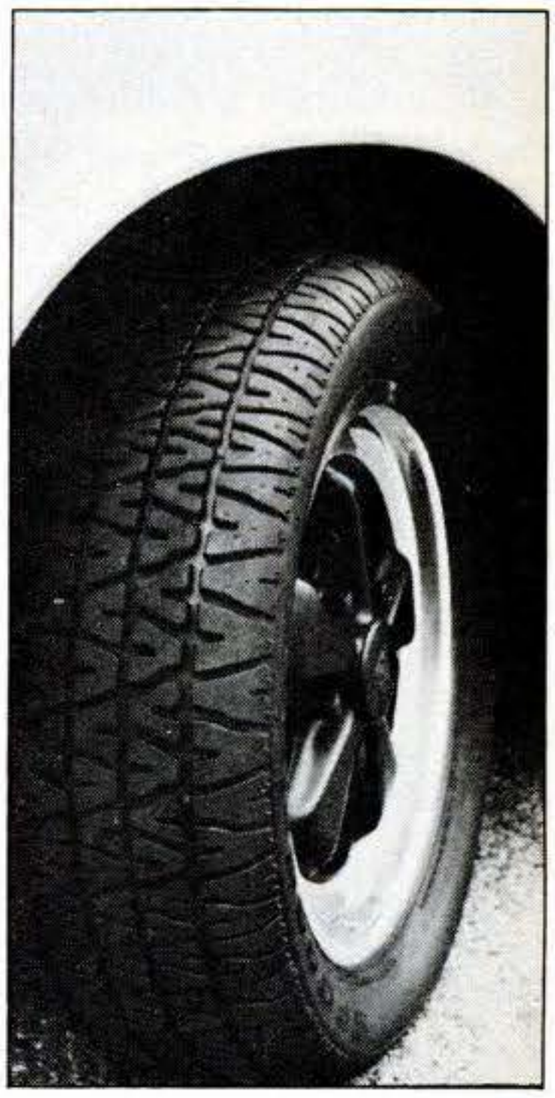
Folding trailer

Need an easy-to-store trailer? Three models from Hartford Trailers (1353 Wacker Dr., Hartford, Wis. 53027) fold down to two feet wide, have beds four feet by four, six, or eight feet. Loads range up to 1,180 lbs. GVW. Prices: from $569 to $795.

Trailer lock

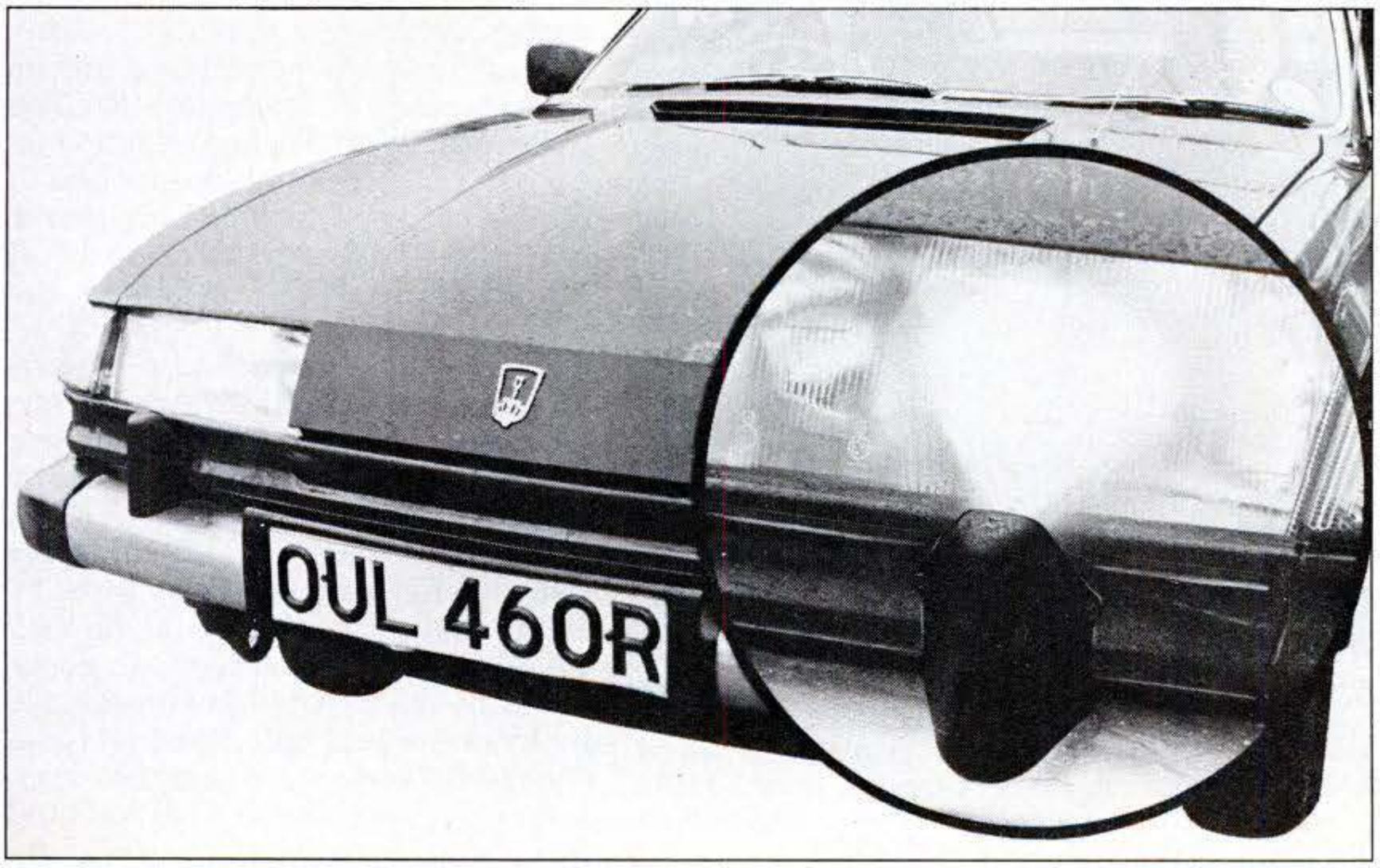
Tow-Lok snaps onto your trailer's coupler to prevent the sticky-fingered from simply towing it away using their own hitches. The unit costs $29. Tow-Lok, Inc. (3360 220th St., Box 98, Farmington, Minn. 55024), says only a key is needed to remove it.





Tenacious tire

BF Goodrich's Comp T/A ultra-high-performance tire features fiberglass and nylon belts, an open tread pattern, and sticky tread compound. It's meant to be a street tire, but is also used for racing. It's available for domestic and foreign performance cars.



Headlight washer

Power Wash sprays cleansing fluid onto your headlights under 40-psi pressure to scrub them clean. Made by Tudor Accessories Ltd. (Dyffryn Industrial Estate, Mynach, Hengoed, Mid-Glamorgan CF8 7XD, Wales), it's similar to those found on exotic sports cars.

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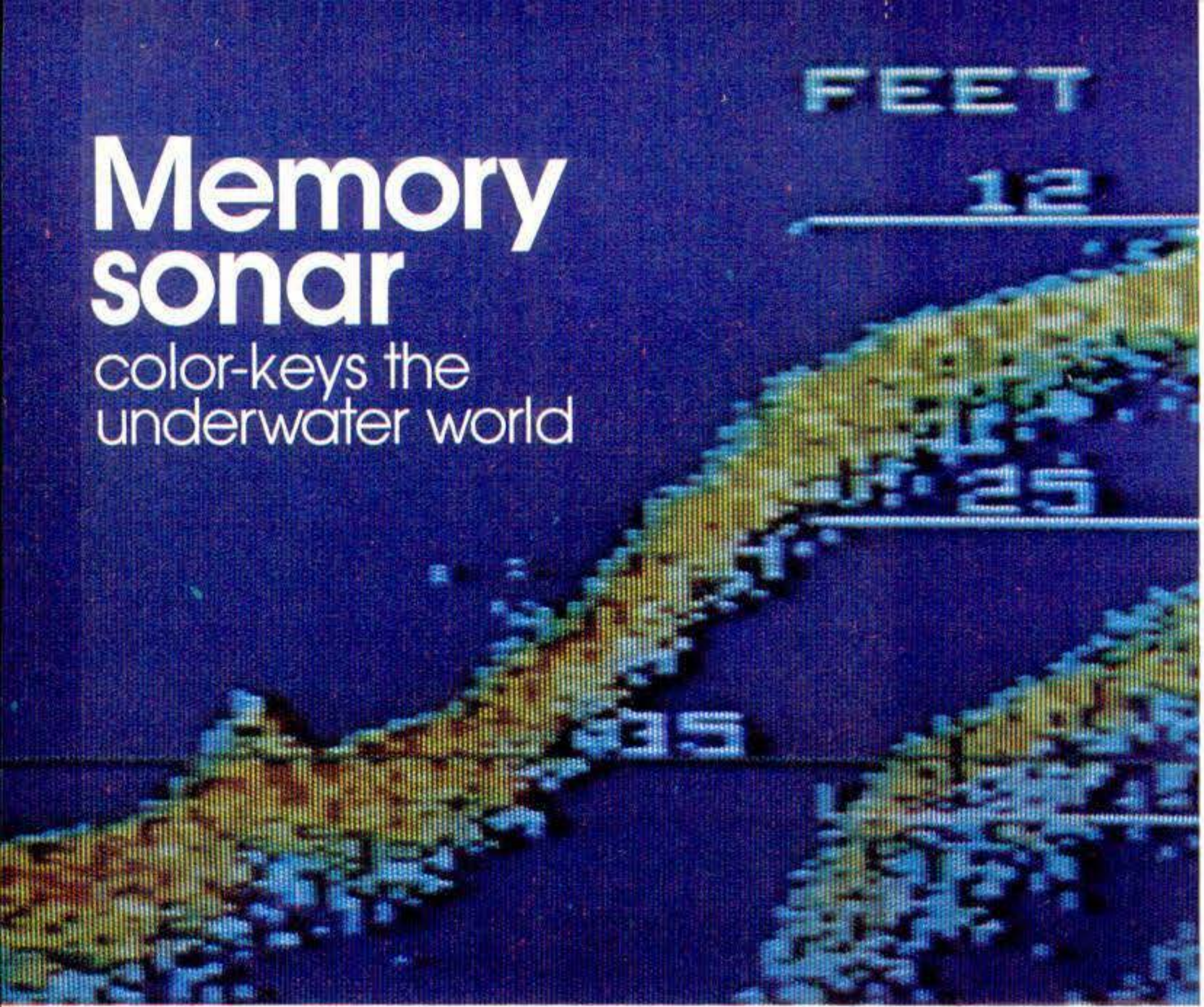
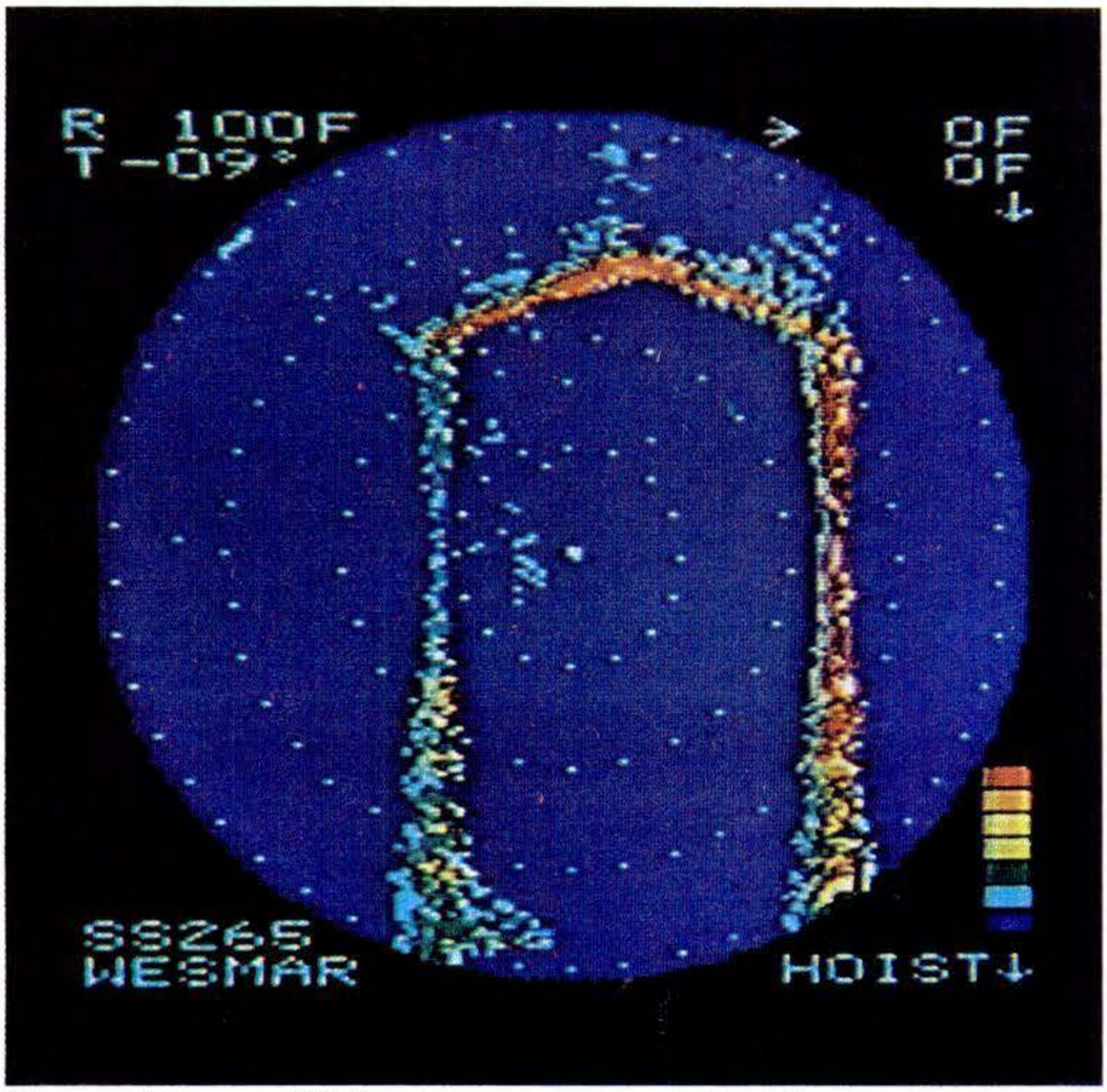
Memory sonar

color-keys the underwater world



Multi-hue sounder display shows section of Puget Sound where it dips from shallows to deeper waters. An underwater peak, blown up to show detail, fills lower part of screen; regular display is at top. Green line is a vertical range marker that shows depth at center of expanded zone. Skipper can also zoom in to examine a chosen target in even finer detail (to three-inch resolution). Wesmar's $2,500 video sounder has depth range of 600 ft. (183 meters or 100 fathoms).



Like an undersea searchlight, color sonar illuminates the waters around a vessel (center dot). Screen above shows a lock in Puget Sound. Text at upper left gives scan range (100 ft.) and transducer tilt angle (nine deg.). To turn on range ring display at upper right, skipper moves a console toggle switch. Dotted ring on screen widens until the ring intersects a target. Its distance and depth then appear next to arrows. Sonar prices start at $5,100 for a model with an 800-ft. range.

By SUSAN RENNER-SMITH

Scouting for sunken treasure? Seeking fertile fishing grounds? Or just looking for a passage through shallows? Whatever your search, it should be easier with a color depth finder aboard. Like Wesmar Marine's memory radar [PS, July '81], the new Omnicolor scanning sonar and video sounder are unique marine instruments.

Color—and a computer—makes the difference. Each unit has a microprocessor that analyzes the echo from an underwater object, then assigns a color based on the relative density of the object. The result is displayed brilliantly on a standard TV screen.

"Strong return echoes from targets such as rocks or reefs show up red," says Wesmar's Dan Doran. "Weaker targets, such as scattered fish, seaweed, or muddy bottoms, are in shades ranging from orange to light blue."

Such discrimination between target densities is a first for scanning sonar, according to Wesmar (Box C19074, Seattle, Wash. 98109). The scanner works like undersea radar, sweeping a beam of sound in a circle around the boat.

"Conventional scanning sonars have a fading phosphor display, just like ordinary radar units," says Doran. By contrast, the Omnicolor's computer memory displays the entire underwater scene, updating it with each scan.

The video sounder works on the same principle, but looks only at the area immediately below the vessel. "The advantage is that the operator can enlarge interesting targets," explains Doran. "A sports fisherman can zoom in on a school of fish, a cruising yachtsman can examine the bottom in great detail, and a salvage operator can get details of a wreck."

Many conventional depth sounders have the same basic capabilities. The difference? Their displays, whether on charts or on videolike screens, are in shades of gray. Deciding whether a gray blob is a school of fish or a reef can be tricky. Color simplifies the task.

The Wesmar sounder also offers a unique type of split-screen display. One side shows a frozen scene chosen from the memory; the other side shows the current scene for comparison.

Both the sonar and the sounder come in slim consoles (17 by three by 10 in.) that can be stacked, along with the identical radar console, in about the same space that one old-fashioned bulky unit would take. "And all three can use the same video monitor simultaneously," says Doran. "All you need is a crossover switch." PS

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NASA's new radial turbine/diesel aircraft engine

Within 10 years, light planes may be powered by four-cylinder diesels

By E. F. LINDSLEY
ILLUSTRATION BY JEFF MANGIAT

MUSKEGON, MICH.

I was standing in Teledyne/GPD's engine lab. Before me was an experimental single-cylinder diesel engine, buried under an unattractive mass of wires and plumbing. Even so, it's one of the most imaginative and exciting engines I've seen, the forerunner of a four-cylinder radial diesel aircraft engine. Airplanes using it are expected to fly in 1985.

Such an engine could easily cut fuel consumption far below the best turbines. It will be lighter, simpler, and more economical than current gasoline engines. And best of all, it won't need high-octane or -cetane fuel.

"We started out with a clean sheet of paper," said Steve Berenyi, manager of advanced products at Teledyne. "We were free to choose any direction we wanted to go."

They began under a NASA contract. Looking ahead, NASA recognized that the gasoline piston-type aircraft engines used for private and general aviation will disappear. They burn too much fuel and require high-octane aviation gas. Avgas will eventually become scarce.

NASA called for new engine ideas and engines with multi-fuel capability. Makers other than Teledyne came up with concepts for rotary (Wankel) engines, small gas turbines, and advanced-technology spark-ignition engines. Teledyne's two-stroke radial diesel seems to be the most developed of these.

Radial gasoline engines were once popular. But turbines and jets replaced them. The radial, however, is ideal for a two-stroke diesel aircraft engine. Alex Brouwers, senior project engineer, said, "We investigated all engine configurations—V's, opposed, in-lines, the whole range—for frontal area, weight, and bulk. The radial came out best."

He pointed to the single-cylinder prototype we were looking at. "It's hard to visualize, looking at this," he said. "But using this type of engine in a four-cylinder radial means a short crankshaft and crankcase. We'll save 100 lbs. of weight on the crankshaft-crankcase area alone."

> "The weight problem? Our engine avoids it because it is a low-compression diesel"

Why a four-cylinder as opposed to the nine or more cylinders common on older gasoline-powered radials?

"To understand that," Brouwers replied, "you have to think in terms of cylinder working pressures. A four-stroke engine fires only at every second upstroke of the piston. A two-stroke fires on each upward stroke. Generally speaking, a four-stroke would need twice the cylinder working pressure for the same power at the same rpm. In other words, you can get the same power with the same pressure from half the number of cylinders by using a two-stroke cycle."

Even so, I couldn't see how a diesel engine, even of the two-stroke variety, could be made light enough to use in an airplane. Diesels, such as the Packard aircraft diesel and the Junker's Jumo, had been tried years ago. They had been found to be too heavy, because of the extra metal needed to handle the diesel's high operating pressures.

"Our engine avoids the weight problem because it is a low-compression diesel," Brouwers said. "With the lower operating pressures, we don't need to use as much heavy metal. The engine uses a turbine compressor to compress the air to a temperature of about 250 degrees F. Then this air is fed to the combustion chamber.

"The preheated air not only makes possible a lower compression ratio," he said. "It also makes the engine much less demanding of cetane ratings. We'd have no trouble running on most of the fuels that jets burn—JP-5 and Jet-A, for example. Their cetane characteristics are acceptable."

While it's clear how low compression plus heated air would permit a lighter engine and still provide diesel ignition, one question persisted: In the past all sorts of efforts were made to cool the air off the supercharger to get a denser charge into the cylinder. It would appear that pushing in heated air would reduce the amount of oxygen available for combustion and cost a lot of power.

Steve Berenyi offered an answer to that. "Part of that loss," he said, "is negated by the extremely high boost pressure. In our proposed 250-hp engine, we're looking at 53 psi, 107 in. Hg [intake-manifold positive pressure] at takeoff. Old-time piston-engine pilots will find such figures startling. Part of the air, however, is

Continued

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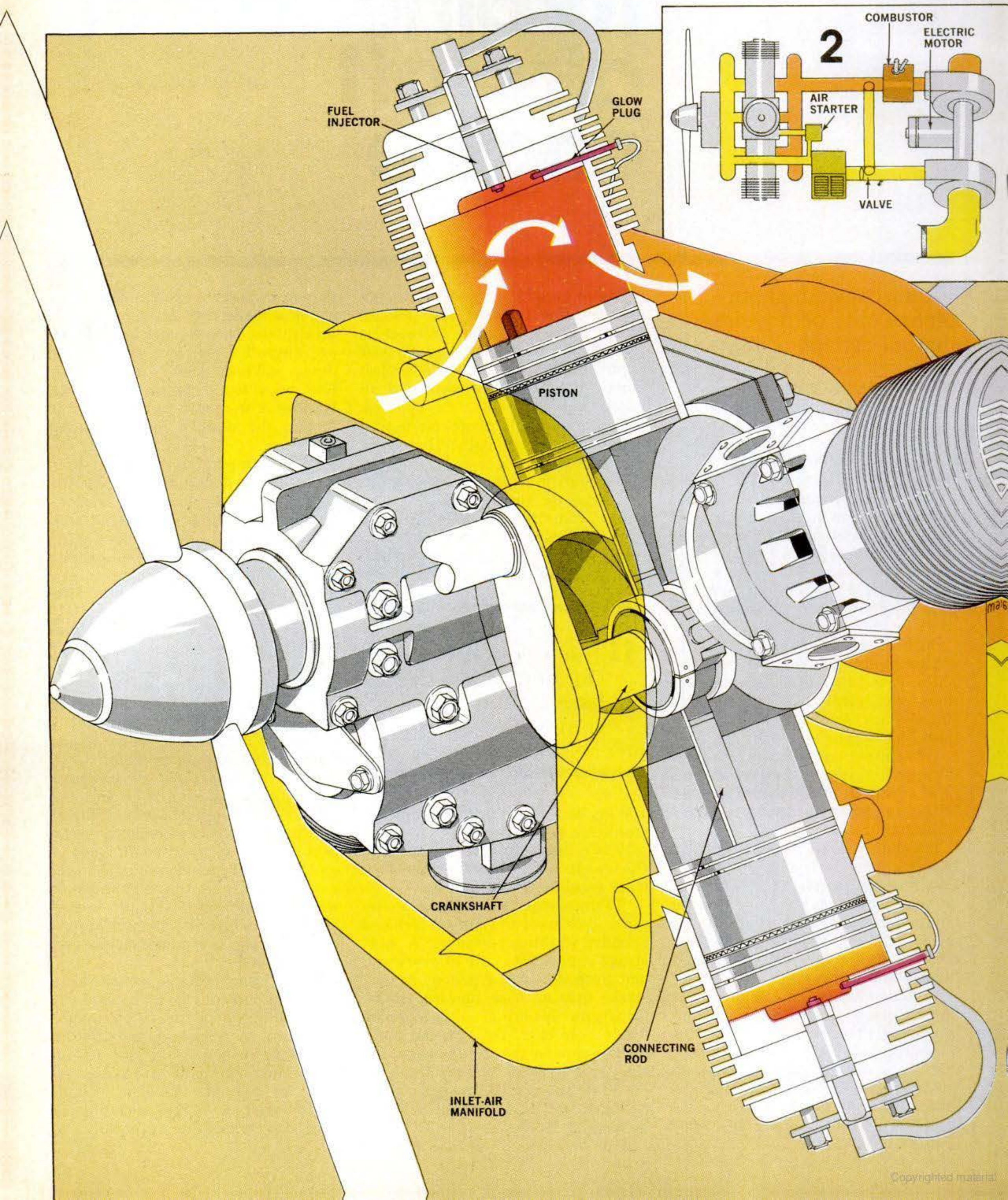
used to scavenge burned gases, and actual peak cylinder pressures are kept below a modest 1,500 psi." By comparison, cylinder peak pressures in conventional diesel engines may reach over 2,000 psi.

The two-stroke cycle makes achieving lighter weight and less frontal area easier because of the lack of valve gear and fewer cylinders. It also makes a blower or compressor necessary to scavenge the burned gases and bring in fresh air. Big truck and industrial two-stroke diesels use mechanically driven Rootes or centrifugal blowers. Some of these use an exhaust valve at the top of the cylinder. Air is blown in through ports in the cylinder wall near the bottom of the piston travel and driven out the exhaust valve. But other two-stroke



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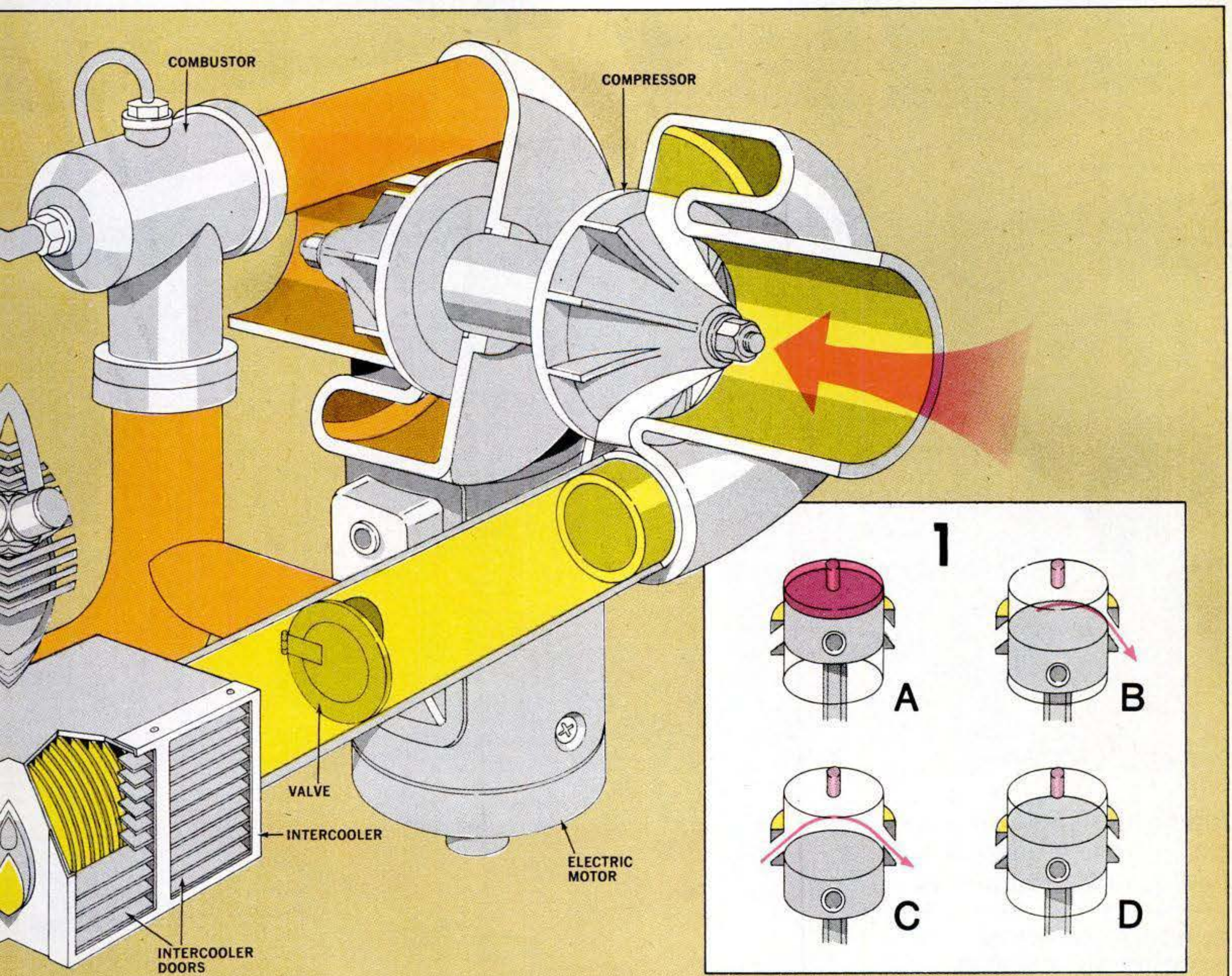
engines use exhaust ports and have no valves at all.

Teledyne, to avoid valves, went to loop scavenging (see drawing). The air still comes in through ports in the cylinder wall, but it's directed upward to loop over at the top of the cylinder and travel downward to drive the exhaust gas out through ports on the opposite side of the cylinder. The trick is to scavenge the burned gases without wasting a lot of fresh air (and the energy to compress it) out the exhaust port. That's part of the research being done on the cylinder I saw on the test dynamometer.

Ingenious and imaginative as the new diesel is, getting it to a prototype and then production stage is a lengthy challenge. For example, the type of

[Continued on page 160]



How the engine works: Exhaust gases turn the turbine, which causes the compressor impeller to turn. The compressor heats the air and forces it through the intercooler (a heat exchanger) into the cylinder ports. The intercooler doors open and close as necessary to keep the temperature of the compressed air from rising above 250 degrees F (the wider the doors open, the more cooling takes place). Each cylinder has a glow plug, which is not normally used for starting except in extremely cold weather but is turned on automatically when power is reduced to descend.

1. Two-stroke cycle: At the top of the compression stroke, fuel is injected and is ignited by hot air (A). As the piston travels down, exhaust ports—which are higher than inlet ports—are uncovered first. Exhaust gases start to rush out (B). When the piston uncovers the intake ports, incoming air forces out the remaining exhaust gases (C). Air continues to flow in until the piston closes off intake ports on the upward stroke (D). At the top of the stroke, fuel is injected and ignited, and the cycle repeats.

2. To start the engine, an electric motor is used to turn the turbine at half speed. The compressor impeller draws in air and heats it by compression. A valve closes off the engine's inlet for intake air, so the hot air is directed through the combustor, where fuel is injected. A spark jumps the igniter's electrode gap, igniting the fuel. The expanding gases turn the turbine.

The turbine now accelerates to operating speed and the starter motor is no longer needed. It becomes an alternator to supply electrical power.

The valve for the inlet-air manifold is opened, allowing the hot compressed air to enter the engine. At the same time, an air starter (using air from the compressor) cranks the engine. Fuel is injected at the top of each piston's stroke. Combustion occurs; the engine is now running on its own. The combustor is shut off, and exhaust gas from the engine turns the turbine. For descent and landing, when engine speed is reduced, the combustor cuts back in as needed to maintain air flow.

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PS editor helps set world soaring record

Riding the wind for a day, two men in a sailplane flew it 1,000 kilometers

By ROBERT GANNON
PHOTOS BY PHILLIP B. DIXON
ILLUSTRATION BY ADOLPH BROTMAN

7:42 a.m., Sept. 28, 1981. I'm writing this in the rear seat of a two-man sailplane a half-mile above Altoona, Pa. Trying to break a world record: out-and-return, multi-place sailplane. Trying to glide 1,000 kilometers. Now Altoona gap—first real trouble.

The pilot was Tom Knauff, holder of 14 national records and owner of Ridge Soaring Gliderport in Julian, Pa. I, as copilot, would take over the controls only when Knauff wanted to stretch.

Which was OK with me. When, at more than 100 mph, you hit turbulence in a sailplane, it feels as if you've struck a small tree. It throws your legs

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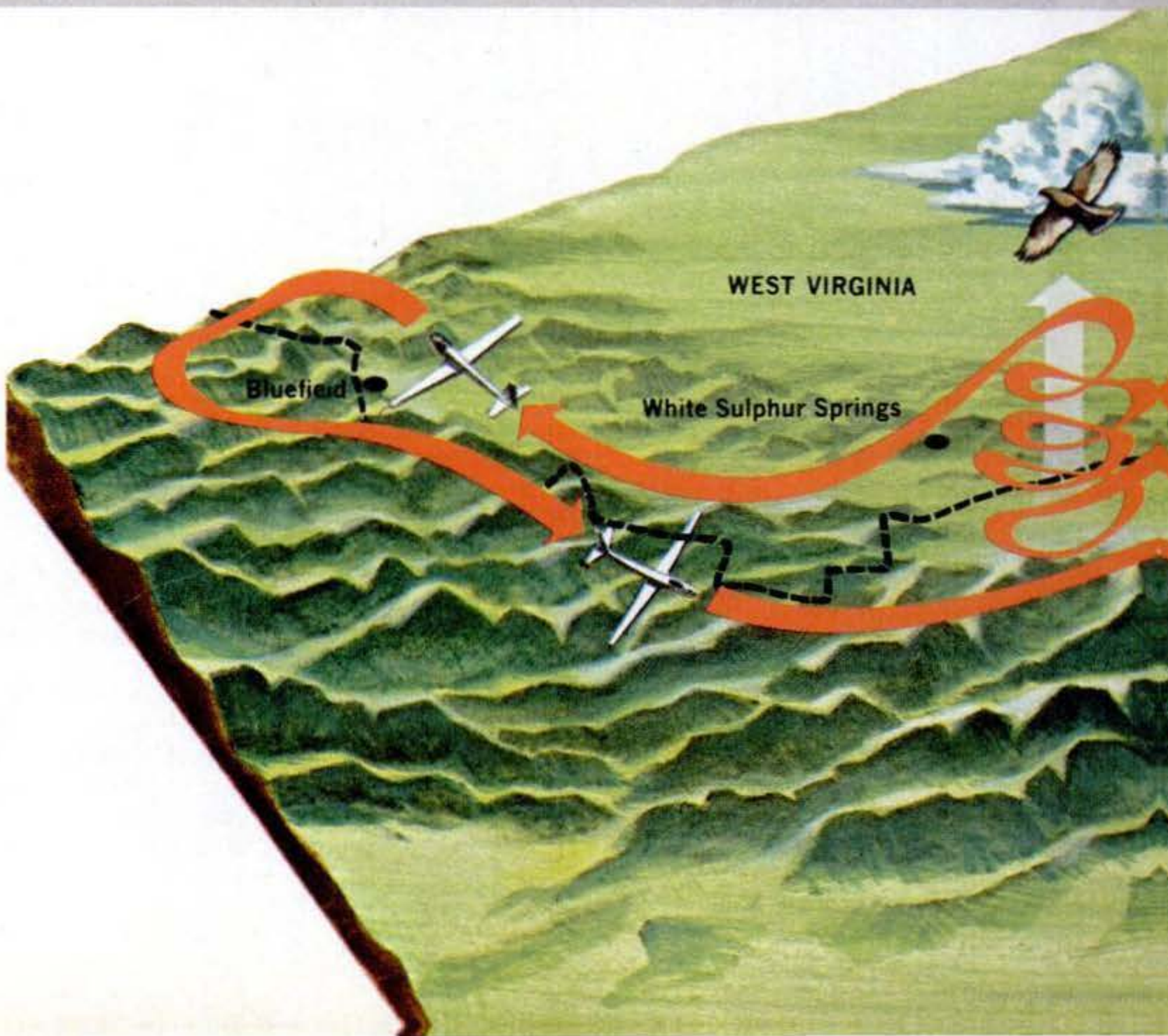

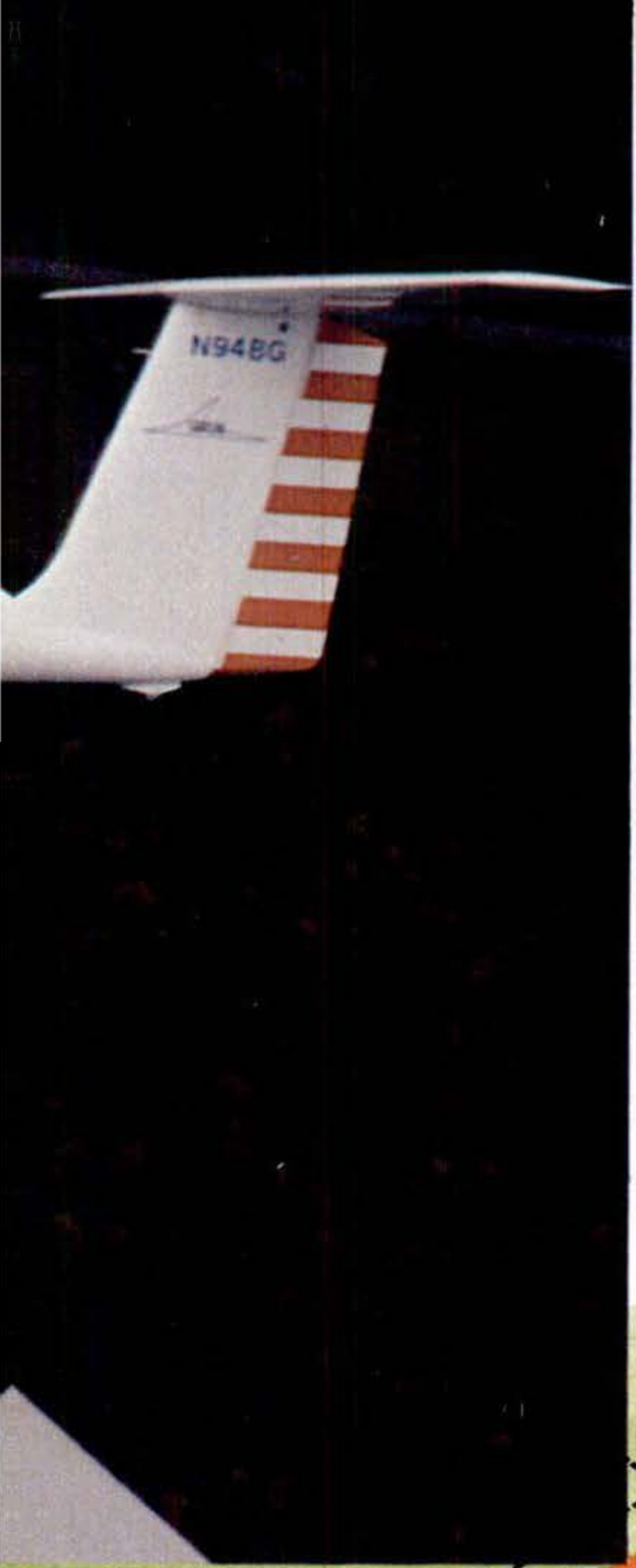

THERMAL
RIDGE LIFT
State College
Julii
WAVE
Altoona
Bedford
Mountain Grove
Seneca Rock
PENNSYLVANIA
MARYLAND
VIRGINIA

Soaring high on wind power (upper left), the 29-ft.-long sailplane grabs rising air with its extravagant 57-ft. wingspan. At end of day-long flight (above right), author and pilot had traveled exactly 1,000.03 km. Circling over four states (map), the super-glider spent half the time riding ridge lift generated by northwest winds slamming into the Allegheny foothills. The pilots spent a quarter of the time spiraling up through the funnel-like thermals that are often topped by cumulus clouds. Clockwise-churning rotor clouds accompany the wave that lifted the sailplane to 10,500 ft.

up, yanks the safety belt into your stomach, smacks your head on the canopy. When it happens intermittently all day long, it can reduce you to vanilla yogurt.

And this trip, if we made it, *would* take all day. We'd soar from the center of Pennsylvania over a slice of Maryland, and along the Virginia/West Virginia border, nearly to Tennessee. Then we'd turn around and come back. We'd follow the Bald Eagle Ridge, the westernmost series of the Allegheny Mountains (see map).

Such a distance had been flown in high-performance, single-place sailplanes, but never in a two-seater. We were trying to break the record of a German named Hans-Werner Gross, who, with his copilot, soared 970.95 km (602.95 miles) a few years before in Australia.

Under a nasty, olive-drab sky, 40 minutes earlier we had been pulled to 1,800 feet by a tow plane, then cut loose. Knauff grabbed ridge lift, circled once to test the air, then headed southwest.

A sailplane, which is a glorified glider, can stay aloft as long as it is in lift—in rising air—which comes in three main varieties: ridge, thermal, and wave (see map). Ridge lift occurs when wind blows strongly against a hill or cliff; the air sweeping up and over it can hold up a plane. And if you turn the plane so it heads along the ridge, pointed slightly into the wind, you can keep going until either the ridge flattens or the wind dies.

Which was what we were doing when, at Altoona, the ridge dropped and the lift disappeared.

The trick to leaping the four-mile Altoona gap was to rise high enough so that we could simply sail across. The plane, a German-built GROB G103 Twin II Astir, has a glide ratio of 1:36—for each foot it drops, it glides forward 36 feet. To guard against dumping down in some field halfway across, we were trying to rise to at least 3,000 feet.

We needed a thermal, a blob of rising air baked loose from a dark field by the early-morning sun.

Knauff felt a nibble at the tip of the left wing. He immediately swung tightly left, circling. Then suddenly we found ourselves spiraling upward, carried aloft like a paper glider circling over a campfire—up, up, until finally the thermal petered out at 3,700 feet.

Knauff pointed the craft toward the gap's other side, and made it with plenty of room to spare.

7:50. Toward Bedford. Ridge running at 100+ mph. Speed was vital. By the time we returned, the late afternoon sun would be producing few thermals, and we might not be able to make it back across the gaps. You make time along the ridge by pushing the stick forward (forcing the nose down) as far as you can without losing altitude or getting too battered. So we snitted along the ridge at about 105 mph, 200 feet above the leaves, while our wing tips flapped through the turbulence.

We had tried this flight last April, but a snowstorm stopped us. We'd had to wait then for the next series of cold fronts to begin marching from Canada across the northeast face of the United States.

The wind must strike a ridge squarely at speeds of at least 20 mph or so for lift strong enough to make speed. Fronts are usually stronger in cold weather, but days must still be long enough for a round trip. If Knauff and I failed this time, we'd have to wait until spring again.

> "He circled, feeling for lift almost as though his arms were outstretched like a soaring condor"

Knauff had been monitoring the weather for weeks. On Sunday night he noted that a gigantic low-pressure area was moving in from Minnesota, funneling 28-mph winds right at the ridge.

Monday morning he woke at 4:15 and listened. Autumn leaves were slapping against the window. Good. He called Flight Service, the 24-hour pilot's weatherman, for verification. A blustery, cold-and-evil northwest wind was forecast. Perfect.

At 4:25 he called me, and a half-hour later, at the Julian gliderport, I was climbing into my flight gear while Knauff readied cross-country essentials:

- A recording barograph that, with an inked tracing, would provide a continuous record proving that we hadn't landed along the way and taken off again.
- A camera to photograph a before-flight "declaration" sheet, the end-of-run turnpoint, and the declaration again after landing. An "official observer" loads the camera and barograph, seals them, unseals them at the end of the flight, and sends film, barogram, and declaration to the international recording agency, the Fédération Aeronautique Internationale in Paris.
- Survival kit, including flares and first-aid supplies.

In the glare of headlights we rolled the plane to the runway, wiped off the dew, and taped the joints for extra streamlining. At 7:02, with the light just strong enough to see a farmer's field if we had to land, takeoff.

8:03. Second hurdle: Bedford, Pa. Caught wave! "Bedford gap coming up," said Knauff from the front. "This is going to be tough. It's 10 miles across." He circled, testing the air, feeling for lift almost as though his arms were outstretched like a soaring condor. Gently now, working a weak thermal, gaining altitude, up, up, slowly up—and finally, "Well, here goes." And out across at 4,100 feet.

Then a strange thing happened. We continued to rise—to 5,000, 6, 7, 7,300 feet in air eerily smooth. We reached the other side of the gap at 7,500 feet and continued to lift in silky silence, in what could only be a wave.

The wind, blowing from the northwest, had reached the edge of the Allegheny Plateau, three miles northwest, paralleling the ridge. The wind dropped over the plateau's edge like an enormously wide waterfall. Air is highly compressible, and as the hundred-mile-thick flow dropped, it squeezed, then bounced up.

We were in that upward-rushing bounce. I looked to the northwest, to our right: a sharp-edged, brilliantly white wave cloud. To the left: characteristic churning wisps of grayish rotor, or fractocumulus. High above us, perhaps at 20,000 feet: the gossamer outlines of the classic, lens-shaped cirriform lenticular clouds.

"Mind taking over a bit while I stretch?" asked Knauff. How could I mind? I grabbed the controls, then, experimenting, removed my feet from the pedals and released the stick. The air was so smooth that the plane seemed to be on autopilot. I leaned far to the side, and the craft began to ease into a barely perceptible turn.

Even with the nose pushed down to gain speed, the plane continued to rise; at 129 mph forward we were climbing at nearly 1,000 ft. per minute, a rate higher than most small powered planes can achieve.

9:56. Seneca Rock, W.Va. Starting down. Tape screaming. The wave finally quit, and from 10,500 feet (at −3 degrees C) we began to slide downward. Suddenly a high-pitched squeal, a screech, began blasting near my ear. The tape that we applied earlier had come loose, and the wind was vibrating it like a clarinet reed. The scream would keep up intermittently throughout the rest of the trip. I wad-

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ded up Kleenex to stuff in my ears. Didn't help.

10:34. Hawk leads way. At Mountain Grove, Va., we were 225 miles from home, 90 from the turnpoint. If this had been in early 1968 we could have turned around and gone home, having beaten not only the two-place out-and-return but the single-place world record, as well.

A few miles later, and another gap, this one near the resort of White Sulphur Springs. The thermals were weak here, and though we circled and circled, we just couldn't find one strong enough to allow us to leave the ridge.

So Knauff tried something new: jumped south to catch hold of another ridge running parallel to ours. "The only trouble," he said from the forward seat, "is that we don't have anywhere to land except that parking lot." Below us was the resort. Heads were turned upward. The parking lot was full of cars.

We needed height, and there was no way to tell where the thermals were—none of the telltale cumulus clouds that often mark thermals' tops.

Just then, off to the left, we spotted a red-tailed hawk, wings outstretched, circling. Knauff sped to just under it, banked into a tight turn, and the two of us, like Popsicle sticks in a whirlpool, spun smoothly upward.

We were covering the lower 50 miles now, and the wind was blasting the ridge at about 27 mph, allowing us to speed, making up for some of that thermaling time. The trees were thrashing, and Knauff bounded along not 150 feet above them, following the ridge contours like a cruise missile.

At 128 mph, we jetted past an observation tower for tourists. An elderly couple staggered backward as, at eye level, we passed within maybe 80 feet. Even though we were motorless, our speed caused us to whistle like a meteorite.

Onward—hurdling gaps, leaping villages, whipping around mountains. Conditions were so perfect, that as we neared the turnpoint, Knauff did a quick calculation: "We're averaging 60.1 miles an hour," he said. "Magnificent."

12:07. Turnpoint. "There it is!" Knauff yelled, and stood the Astir on its wing tip to circle the Fincastle Country Club just beyond Bluefield, Va. He snapped a photo with his sealed Instamatic, then passed it back to me for another shot. Then back to the ridge again at the same breakneck speed, toward home.

I was glad. In fact, I'd just as soon the trip be over. It had been overwhelmingly exciting, but the combination of the squealing tape, no coffee, and ballooning sinuses from altitude changes gave me a headache worthy of Guinness. My stomach ached from lurching against the seat belt; my legs hadn't been straight in five hours.

But we were going home fast—past the notches, mountains, gorges—touching 137 mph, the fastest sustained speed of the day.

1:28. Mountain Grove—landing? And then, trouble. The beautifully nasty northwest wind gentled to a boring breeze. The problem was the wave—that marvelous wave that we had welcomed early in the trip. Waves don't stop with one bounce, but undulate like ripples downstream from a rock.

We were traveling through the second downwind harmonic, which was blocking most of the ridge lift. Knauff slowed the plane to a crawl (50 mph, 10 mph above stall speed) as he urged and cajoled and nudged the craft along. "Pick out a field," he said, "I don't think I can hold it." That was something I had been doing anyway. But they all seemed too small or were spotted with cows. I suddenly thought of the guy who had landed at a drive-in movie, among the posts.

> "Figure-8'ing along the ridge we flew, feeling, sniffing, trying to gain height. Nothing"

We found a thermal and rose 200 feet. It died. We caught a little ridge lift for another hundred feet, then settled down again—then a little more ridge lift, another weak thermal, and then up ahead, the trees were waving. Knauff gently coaxed the plane over—and suddenly that wonderfully welcome upward surge.

The eerie silence of the wave settled over us. Smoothly the air elevated us. But the worst was still ahead: Bedford gap.

4:14. 127 mph to 0. On the ridge approaching Bedford, the strong northwest winds continued to support an average speed well in excess of 100 mph. But then, *clump,* we hit the Bedford gap. Not a thermal in sight. The day was too late. The rays of the sun, now slanting, no longer broiled loose hot blobs of air from the valley. Back and forth figure-8'ing along the ridge we flew, feeling, sniffing, trying to gain height. Nothing.

Suddenly Knauff spun the plane around and headed south, away from the ridge. "We'll never make it if we keep fooling around here," he said. "We'll take the back route and try to thermal north."

I pulled out the chart and saw that another ridge, Tussy, wedged out from Bald Eagle and gently veered east. We could follow it, but eventually we'd have to skip back to the main ridge—directly into the wind.

5:22. Running out of time. For 50 miles, bypassing both Bedford and Altoona, we bounded at top speed along the new ridge. Now, as we passed Spruce Creek, we had soared farther than any other two people in the world. But if we landed here, none of it would count. There was one good sign: In the reddening sun, small cumulus clouds were appearing again. Now, at 3,000 feet, Knauff turned north, heading into the wind. If we could make this one last six-mile hurdle, we would be home.

By this time I was so tired, so sore, so cramped, so sick that all I could do was hang on, braced, jaw clenched, for the next bump, squinting in the sun, grinding my teeth to distract me from the tape screech.

But Knauff had to work. More than 10 hours from launch, he was laboring harder than at any other time.

His head was on a swivel. Face upturned he scanned the sky, searching for fresh, growing clouds, rejecting those dying of old age, aiming for those just forming, checking his instruments, circling to gain 50 feet, a hundred, another hundred. We fell to 2,500, then clawed back to 3,500, circled, plunged forward, circled up again, working, faltering, straining, talking the plane across—and then finally, at 5:54, he said softly, "We're OK," and pushed the nose down to skim through a cut in the ridge, *our* ridge.

It was then that I realized what makes a champion distance pilot. It's not only the superb technique, not only the sensitivity to the atmosphere, the outstanding judgment, not even the extraordinary instincts. It's the endurance, the energy of an athlete, the tenacity.

5:59. Made it. The field was in sight now, but through my headache I could hardly see it. My muscles, tensed for 11 hours, yearned to relax. My hands ached simply from holding on. But my knees would soon stretch at last, my eardrums reshape.

And then as we began our descent, I noticed that we were going much faster than we should be—faster, and faster, until suddenly I felt my cheeks sag and my eyeballs pull inward.

My God. To celebrate, Knauff was doing a loop. PS

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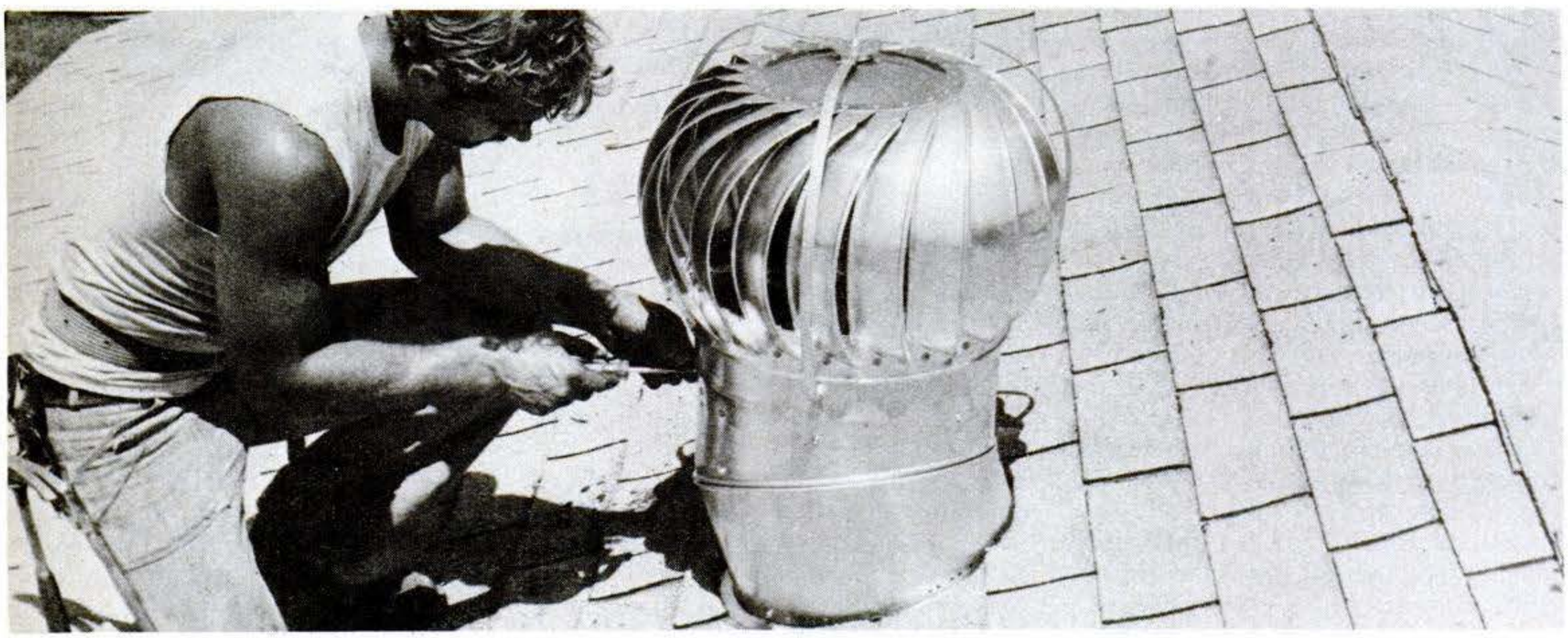
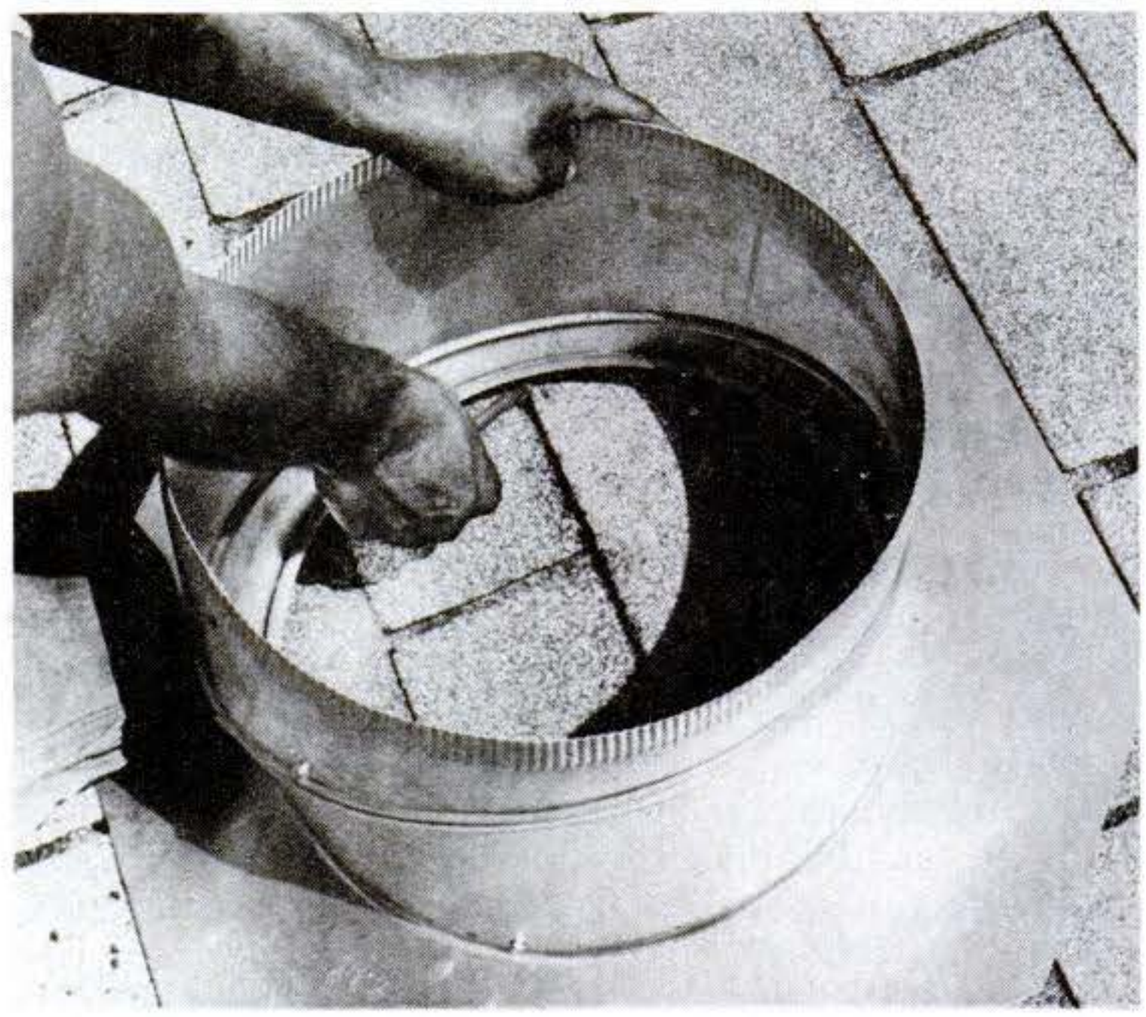
Two routes to summer cooling

1. Install a roof turbine



Wind-driven roof turbine cools home indirectly by venting attic. Stale air goes out turbine; fresh comes in under-eave vents.

Clipping the corners off the turbine's base plate will ease the later job of sliding the unit under the loosened asphalt shingles.



Find the center between rafters as described in the text. Then position the base and trace around its inside circumference.

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Keep the air moving with a whole-house fan or wind-driven roof turbine

By DANIEL RUBY and LOUIS HOCHMAN

The lazy way to keep your home cool is to crank up the air conditioner. That's also the most expensive and least efficient way. A better approach is to install an inexpensive ventilation system that prevents the buildup of heat and humidity in the first place—so that you'll need air conditioning only when it's really steaming outside.

Many houses get uncomfortably hot because air in the attic is permitted to stagnate and collect heat as the sun beats down on the roof. Even if the attic is perfectly sealed, much of that heat is transferred by conduction and radiation to the living area below. (A related problem occurs in winter when unvented attics allow condensed moisture to accumulate.)

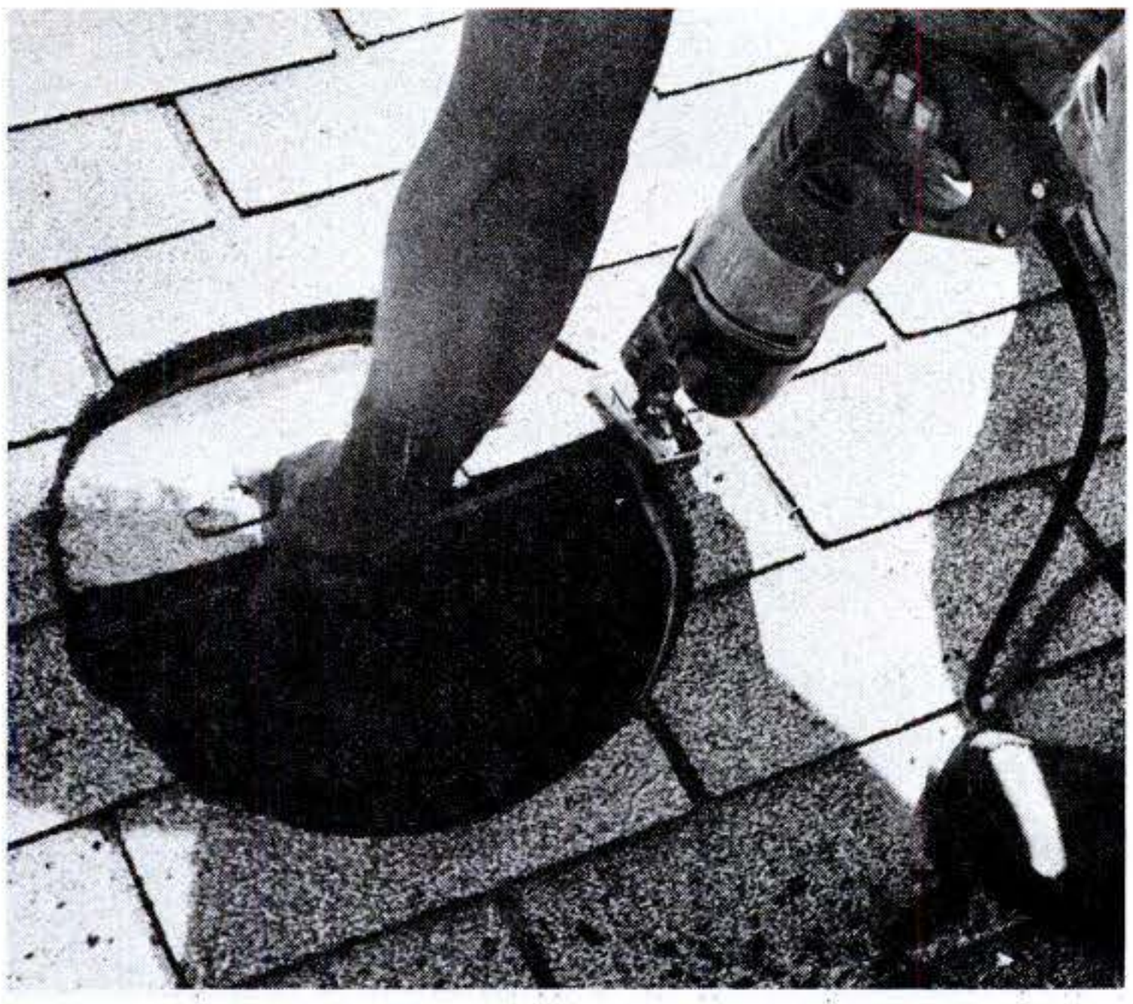
Solution: Air out your attic. Two effective ways to do this are with a wind-driven roof turbine or a whole-house fan. A turbine moves air through the attic only, but it indirectly lowers temperatures throughout the house. Its vanes are powered by the wind, so it cools your house with no impact on your electric bill. Whole-house fans are electric-powered, but the watt-hours they use are insignificant next to the power that air conditioners consume. The fan mounts in your attic, but it draws in air through open windows in the living area, so it has a direct cooling effect. (Never operate a whole-house fan without opening a window—especially if you have gas appliances. Negative pressure can snuff pilot lights.)

Both systems require suitable vents for intake or exhaust. When installing either system, make sure that your attic has sufficient under-eave, gable, or ridge vents.

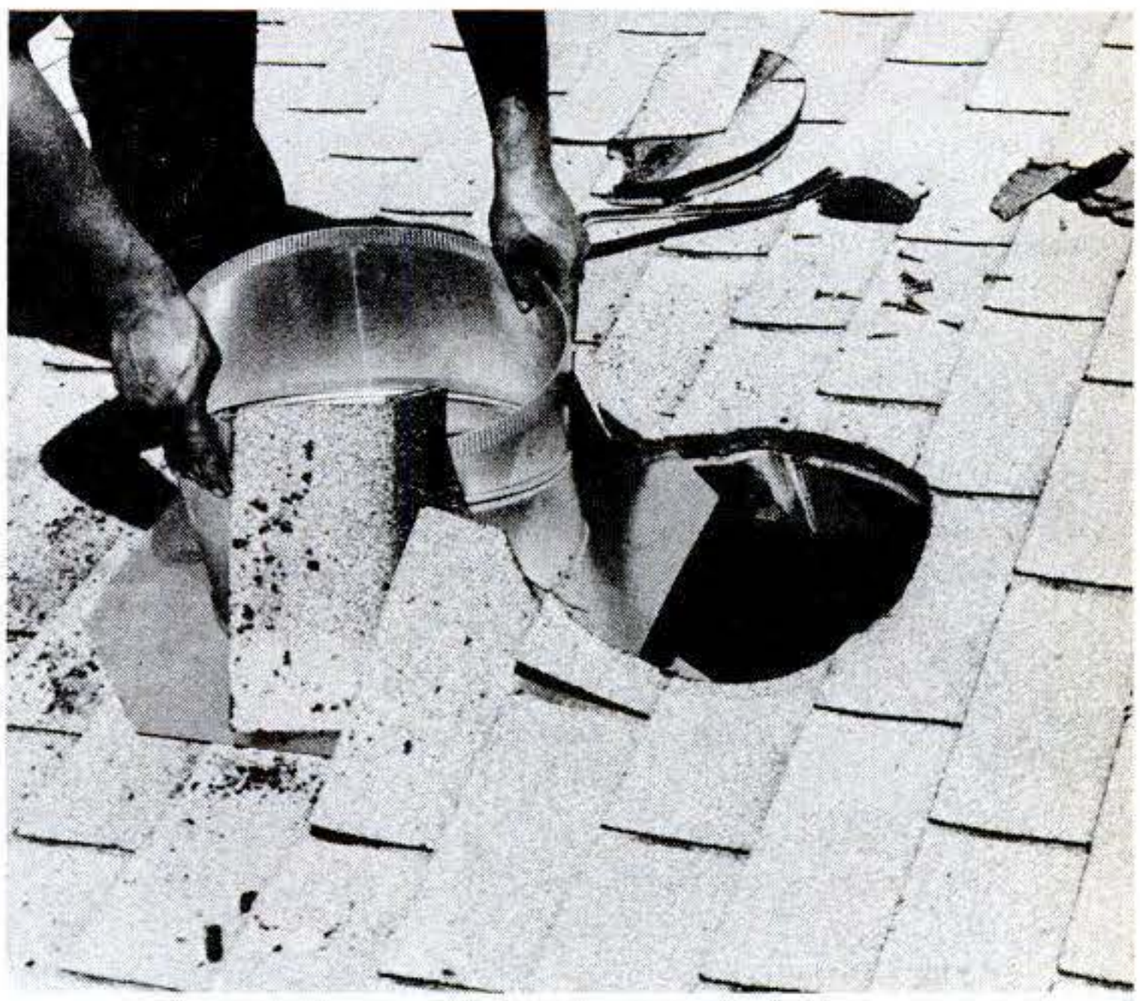
The picture sequences below and on the next page run through sample installations. Both can be homeowner jobs: The Emerson fan pictured requires no cutting of joists or framing. Emerson fans are made in three sizes—for houses ranging from 1,200 to 2,300 square feet. They are available at hardware and home-center stores for $160 to $200.

Our roof turbine is a 14-inch aluminum unit from Sears ($40). Its light-

Continued



To cut circle, first saw small starter hole to serve as a handhold for removing cutout sections. Then cut two semicircles.



Remove nails from the shingles around the hole and slip base underneath until snugly in place. Replace shingles (see text).

Drive large, galvanized nails through the base plate on all sides to anchor the unit. A dab of tar on each nailhead prevents leaks.

Align the unit by spinning the neck sections and checking with a carpenter's level. Secure the turbine to the base with screws.

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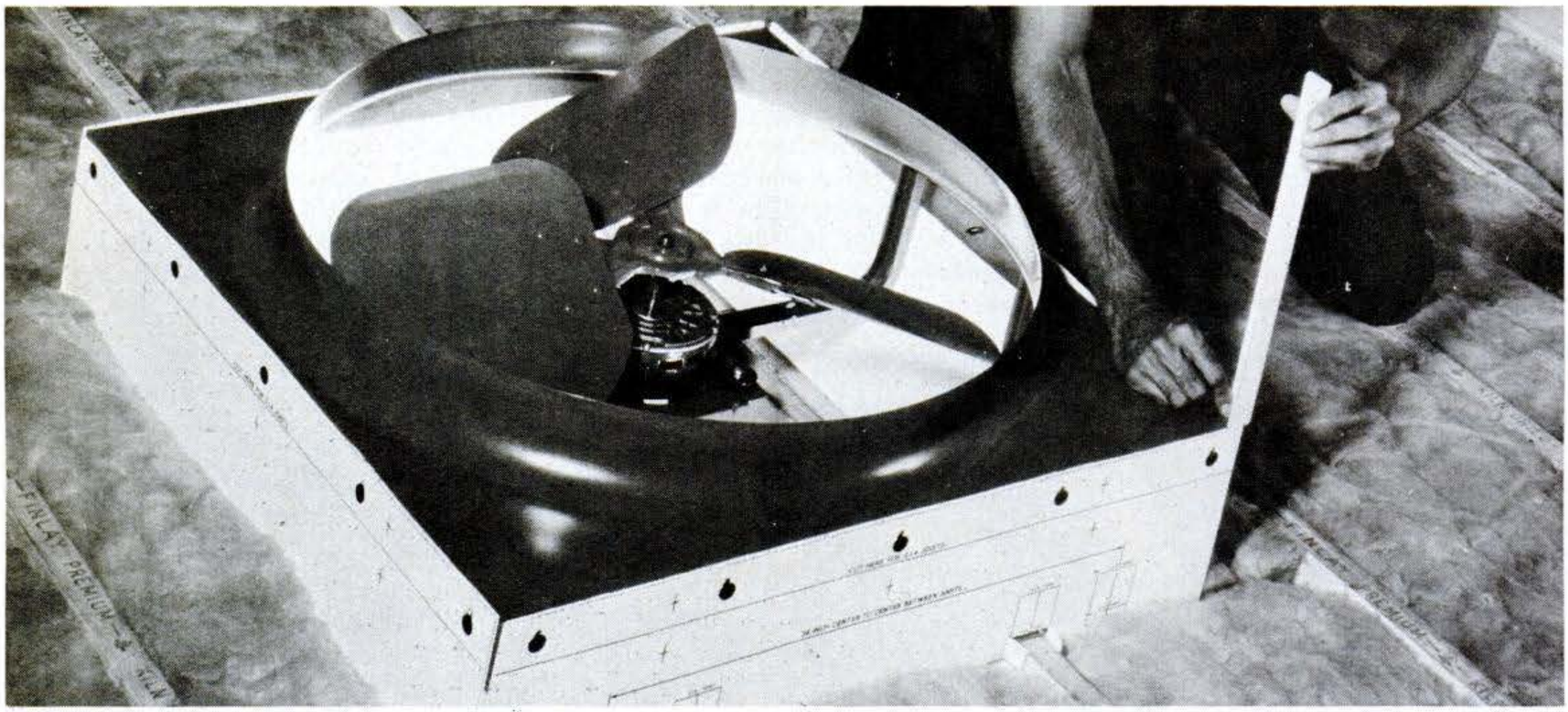
weight construction makes its vanes sensitive to the slightest breezes—not the case for heavier galvanized models. Two turbines were installed by coauthor Hochman to handle an 1,800-sq.-ft. house—positioned a quarter the length of the roof from either end and three feet below the peak of the roof so that the turbine tops are exposed to wind from all directions. (Lucky Installations of Van Nuys, Calif., offered some tips that made the job easier and the results neater.)

To find the center between rafters, make a saber-saw cut through the roof at the point where you want to mount the unit. Continue the cut horizontally until the blade contacts a rafter, then turn the saw around and cut the other way until the blade hits the opposite rafter.

After the turbine's base plate is installed over the hole, replace loosened shingles so that uncut pieces go under the plate and cut sections go over it. This ensures that rain will run off without leaks. PS

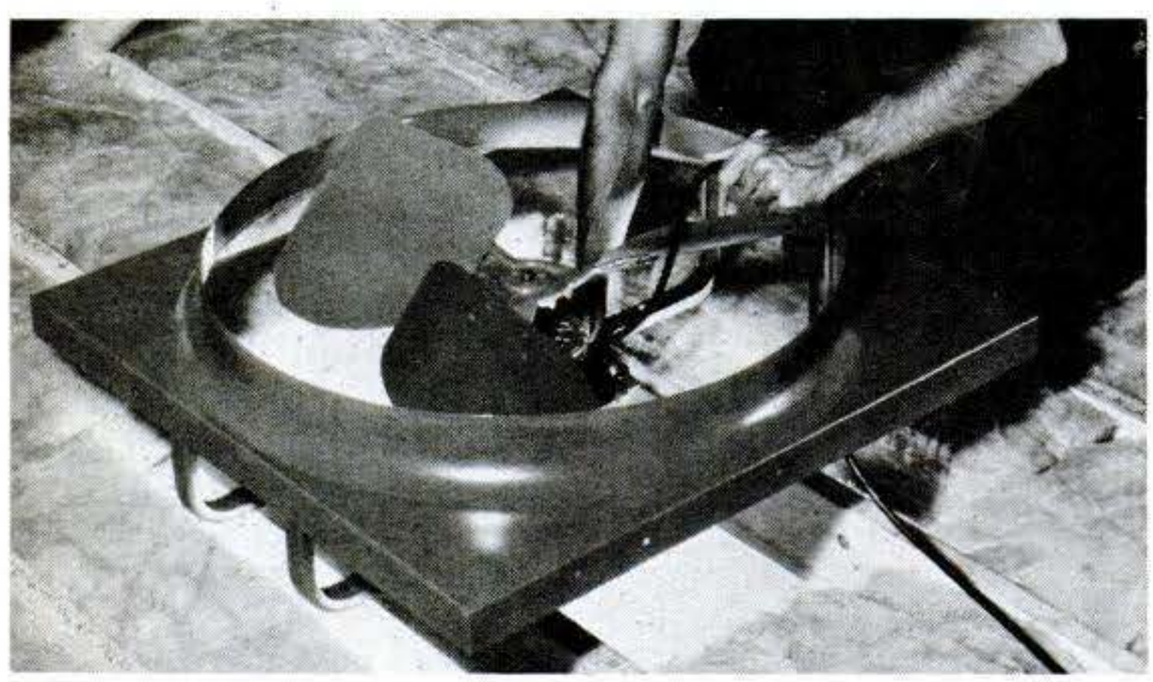
2. Install a whole-house fan



Whole-house fan cools home by drawing in fresh air through open windows while expelling hot, stale air through attic vents.

To install Emerson fan, decide where to locate it (centrally, if possible), then scribe ceiling cut with supplied template.

Cut out scribed section; lift fan through hole. Screw supports to joists. There's no need to cut joists or build special framing.



Supply 120-V AC line power per local codes, and wire to fan. Cut slots in plenum sleeve liner and attach with snaps (top photo).

Screw lightweight, louvered shutter in place over the ceiling opening. Shutter opens and closes automatically with fan use.

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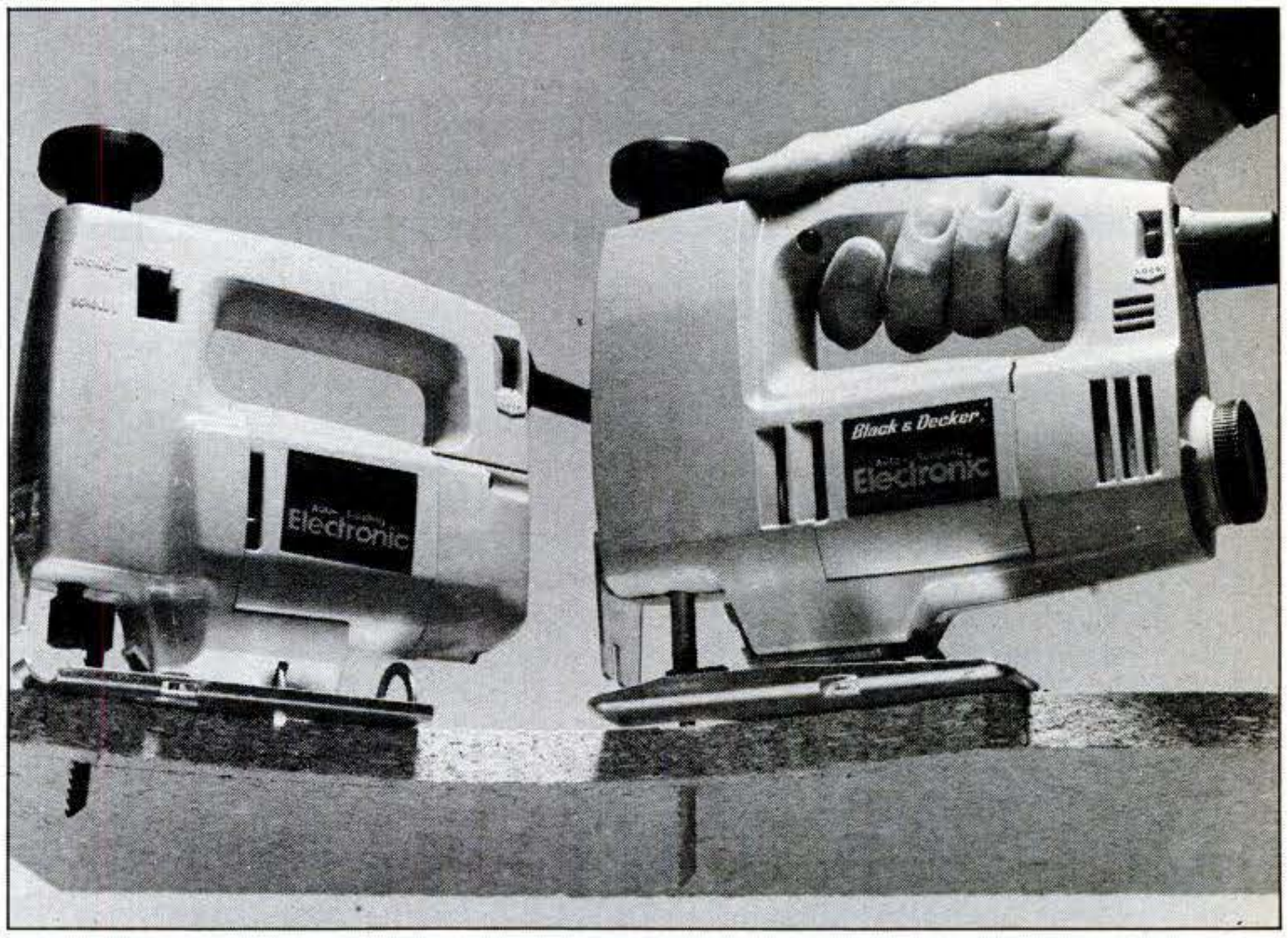
Electronic jigsaws

deliver power to match the load

These brawny tools handle heavy cuts—and delicate curves

By A. J. HAND

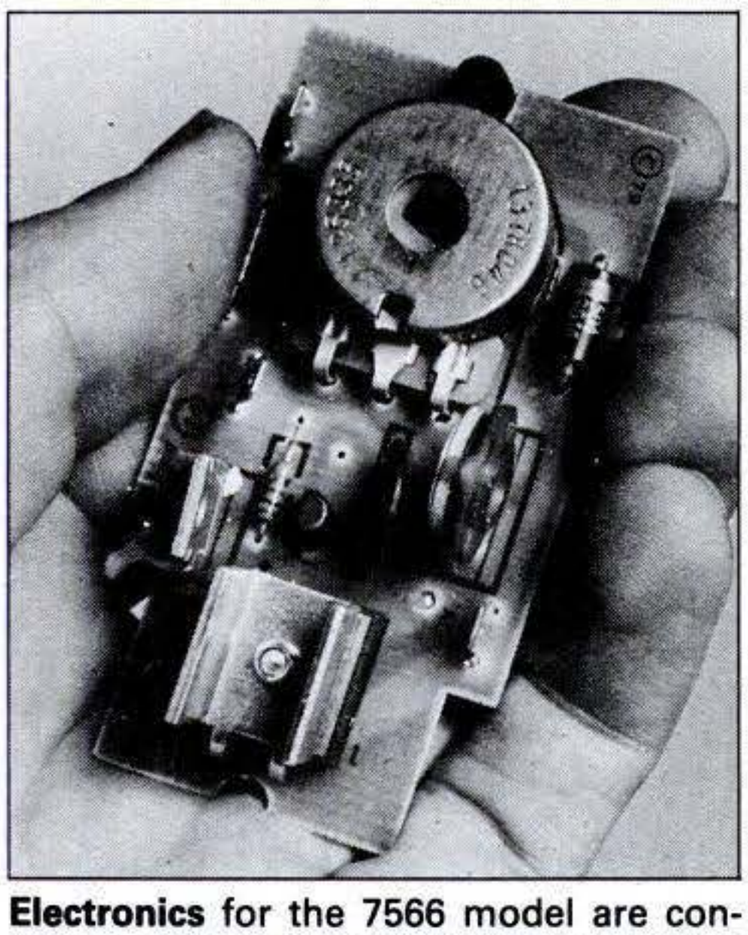


Black & Decker models 7578 (left) and 7566 feature electronic speed control, manual and automatic scrolling, sawdust blowers, and double insulation. Note that the blade on the 7578 is in the auto-scrolling position, slightly to the rear of the reciprocating shaft. In that position, the blade is free to caster.

Using Black & Decker's two new electronic jigsaws is a bit like driving a car with turbocharger. The more load you put on these tools, the more current their electronic circuits will feed to the motors. The result is a great feeling of power. It's hard to slow the saws down, even when cutting two-inch fir.

That power is nice to have, but it also takes some getting used to. Since these tools don't bog down, there's a great temptation to force them. And when you force jigsaws, you break blades. Even without electronics, these are top-of-the-line jigsaws. The 7566—the bigger of the two—is especially impressive. Its main features include:

- A one-inch stroke for fast cutting and long blade life.
- A reversible shoe. Turn it around and the blade fits through a narrow slot that minimizes chipping when cutting brittle stock such as plywood.
- Automatic scrolling. You mount the blade in a special clamp on the trailing edge of the reciprocating shaft, then unlock the scrolling head. The blade is now free to "caster" and will automatically pivot as you push the saw in the desired direction. You can also scroll manually, guiding the blade by turning the scroll knob atop the tool. Personally, I get better control this way.



Electronics for the 7566 model are contained on this printed-circuit board. Two solder joints and three clip connectors wire it into the jigsaw.

Which to choose?

The smaller saw, the 7578, also has the scrolling feature. It has a shorter stroke than the 7566, but its higher stroke speed helps compensate for that to a degree. And I found its combination speed-control/thumb switch more convenient than the big saw's separate speed dial and trigger switch. This, plus the saw's smaller size and lighter weight, would make it my first choice for doing intricate scrollwork. If, on the other hand, I wanted a jigsaw that could handle heavy, straight cuts as well as curves, I would choose the extra capacity of the 7566.

The 7578 sells for around $50; that's about 30 percent more than a roughly similar B & D saw without electronics. The 7566 is about $85. B & D makes no other saw with as much power or as many features. PS

Specifications: B & D's electronic jigsaws

Model	Max. hp	Shoe type	Speed range (spm)	Capacity	Bearings	Approx. price
7578	1/3	Tilting	0–3,200	2", softwood; 1", hardwood	Sleeve	$50
7566	1/2	Tilting, reversing	1,300–2,800	4", softwood; 2", hardwood	Ball, sleeve, and roller	$85

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Ready your mower
and double its life

Simple checks make cutting easier and safer—and your mower will last longer, too

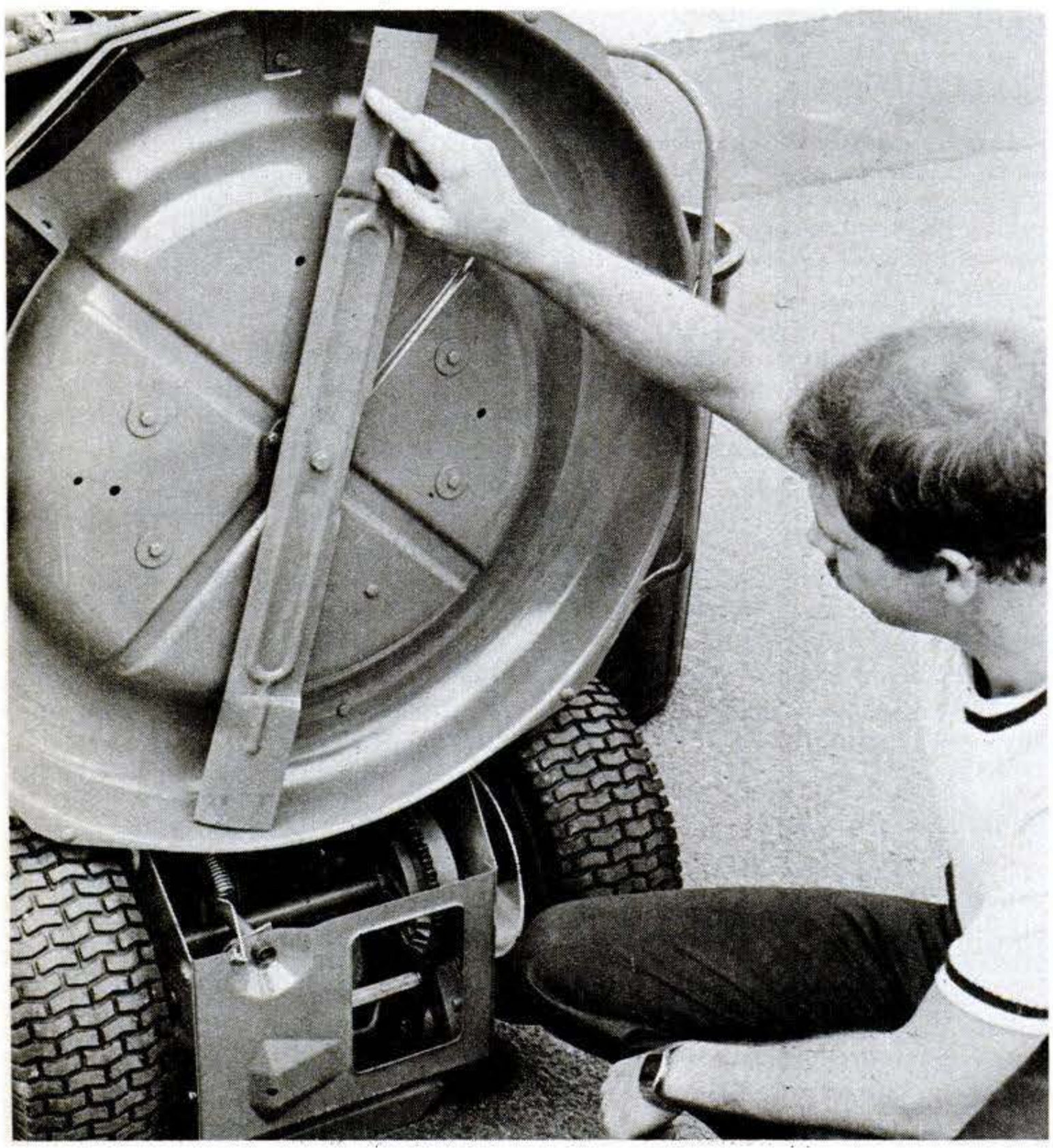
By WILLIAM J. HAWKINS

Ready or not, your weekly war is about to begin—the grass is growing. And, short of converting your yard to a rock garden, there's little you can do but get prepared to do battle. That means a spring check of your mower.

Putting your mower in shape has special advantages, according to experts at Jacobsen, a major mower maker: Not only will it make your job easier this season, but it will increase the life of your machine—up to two times, they claim.

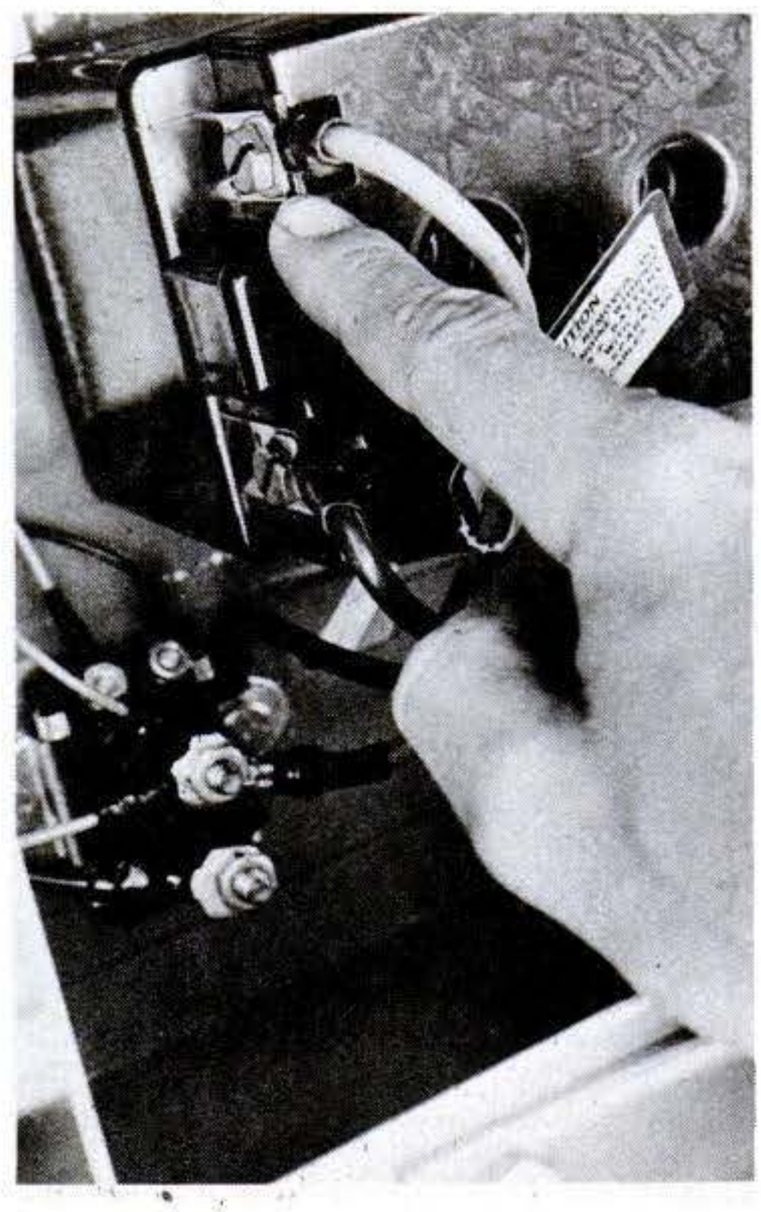
The series of photos here illustrates major points you should check. While a riding mower is shown, most check-ups will apply to walk-behinds and garden tractors, as well.

In general, give the mower an overall inspection—look for cracks and loose bolts or wires, and be sure all safety guards and devices are in place and working properly. For more specifics, check our captions. But before you begin, be sure to *disconnect the spark plug*. PS



Check the blade: If it's bent or cracked, replace it. If it's worn, it must be sharpened. Also check it periodically during the season—right away if it strikes a stone. Tighten blade and motor bolts.

Tighten and clean all electrical connections. Some corrosion may be removed with baking soda and water. Badly corroded terminals may have to be replaced. Replace frayed or dried-out wiring.



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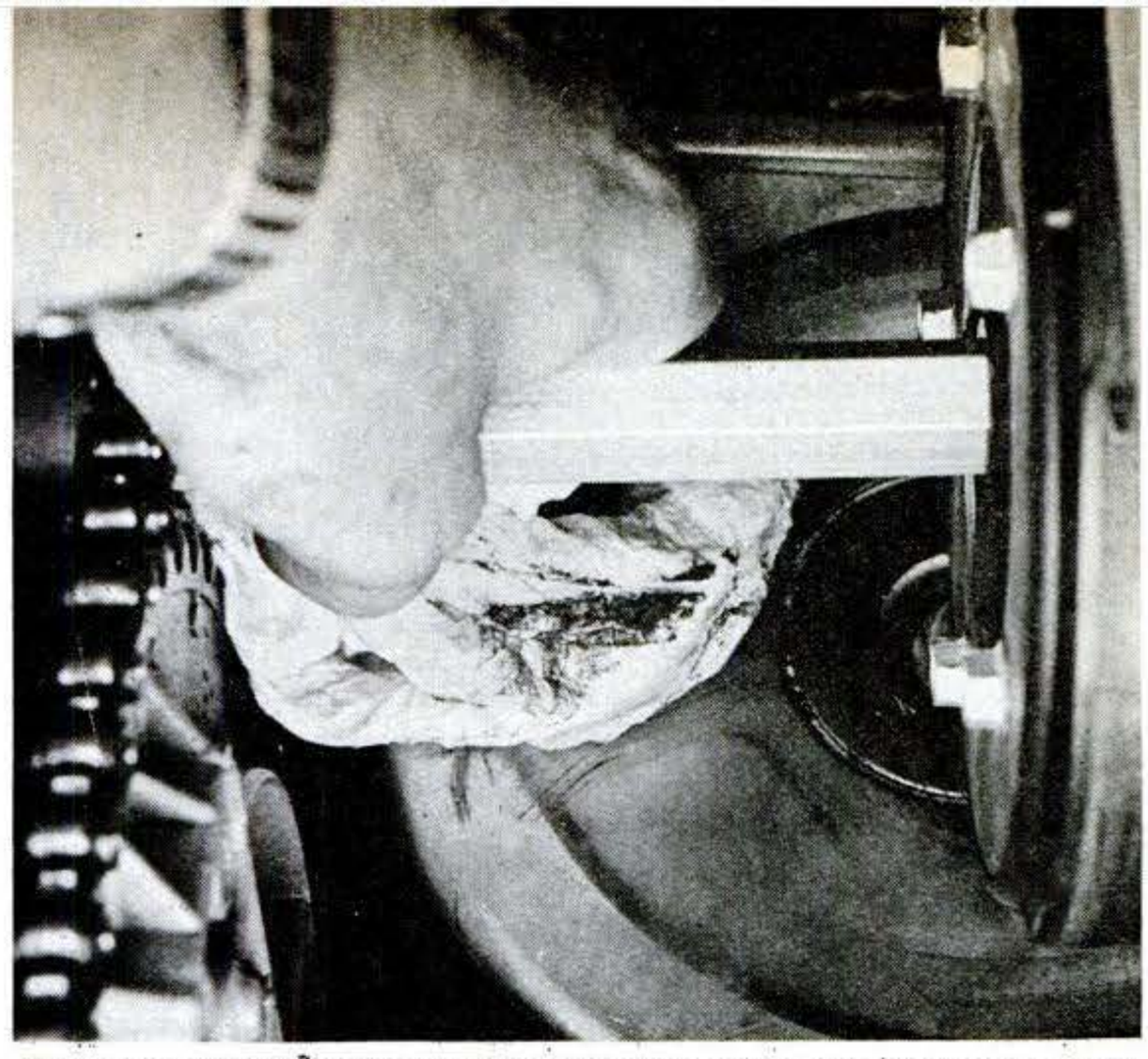
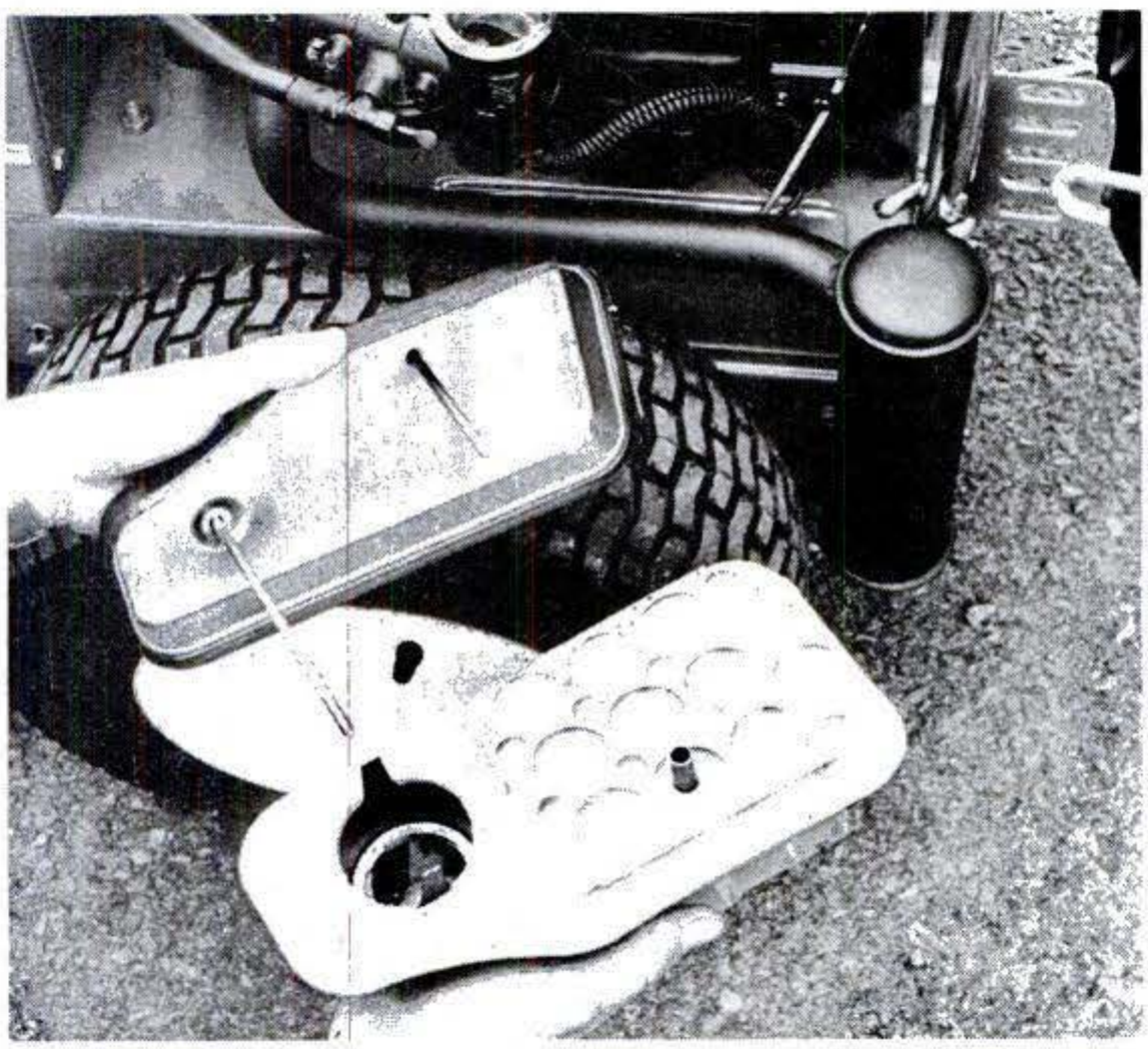
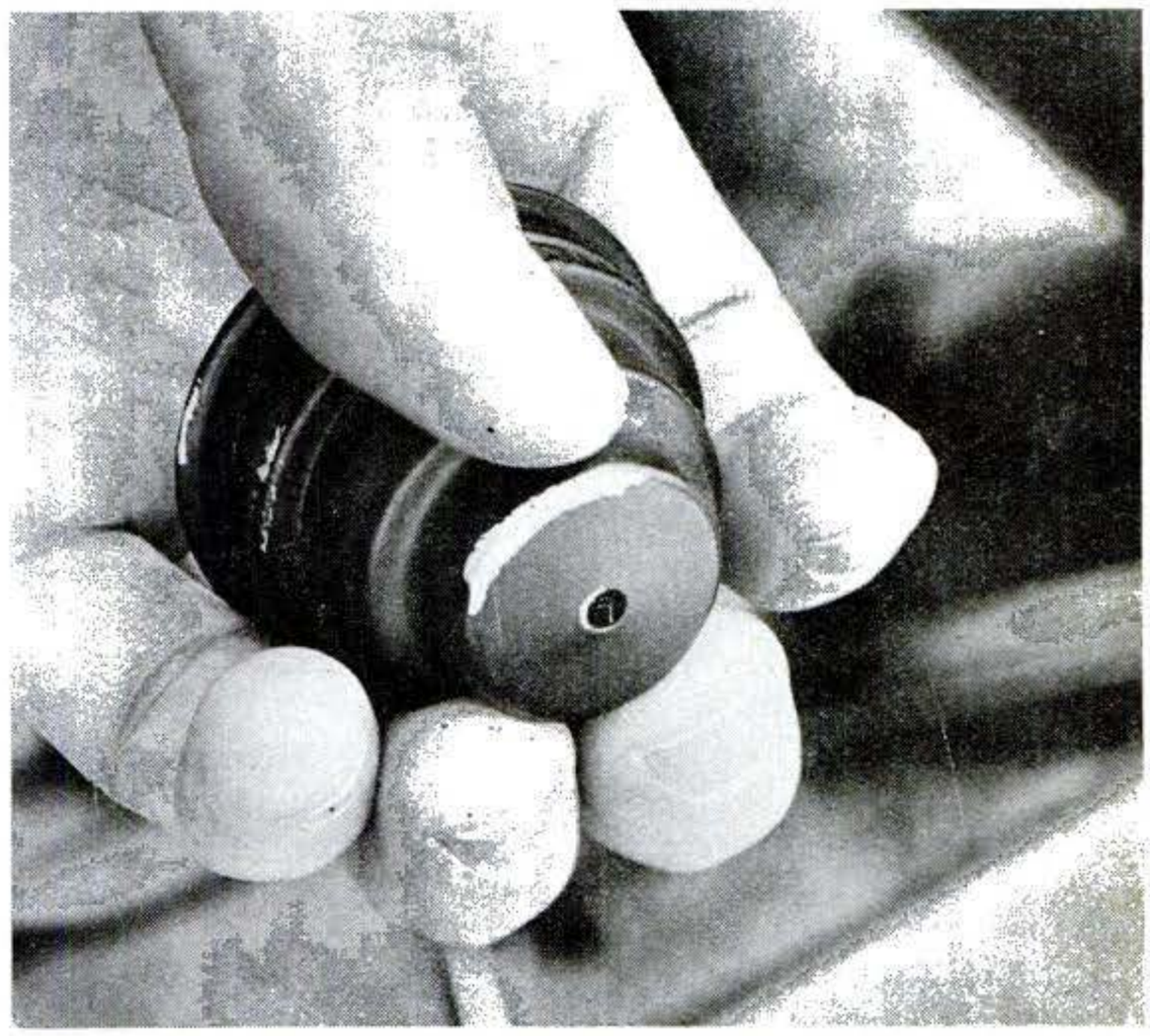
Remove and check the spark plug. If the contacts are pitted or burned, replace the plug. If not, then clean them with a wire brush and re-gap the plug to the manufacturer's specifications.



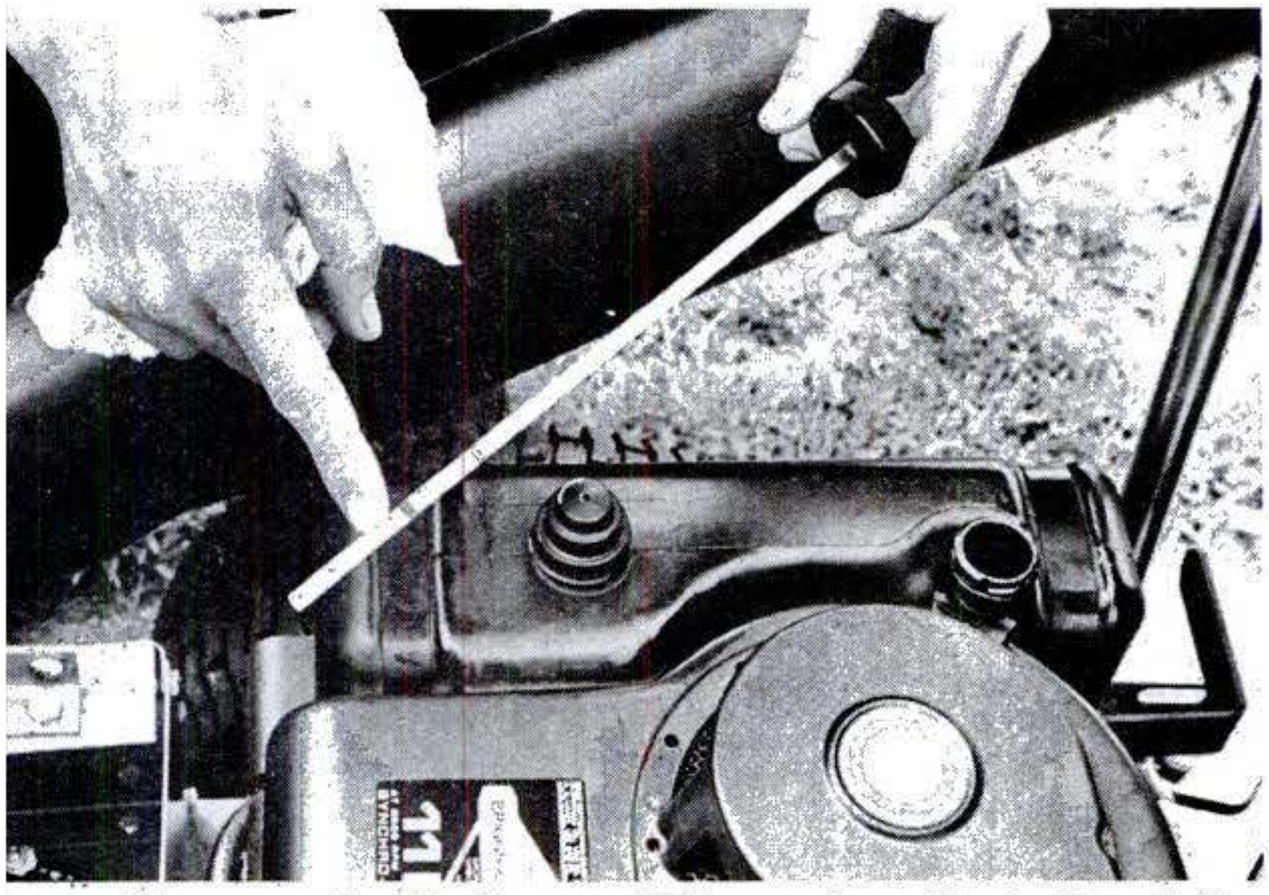
Remove all oil and grease from the drive-disc assembly by using a nonflammable solvent. A glazed drive disc can cause the system to slip, resulting in a loss of traction on slopes.



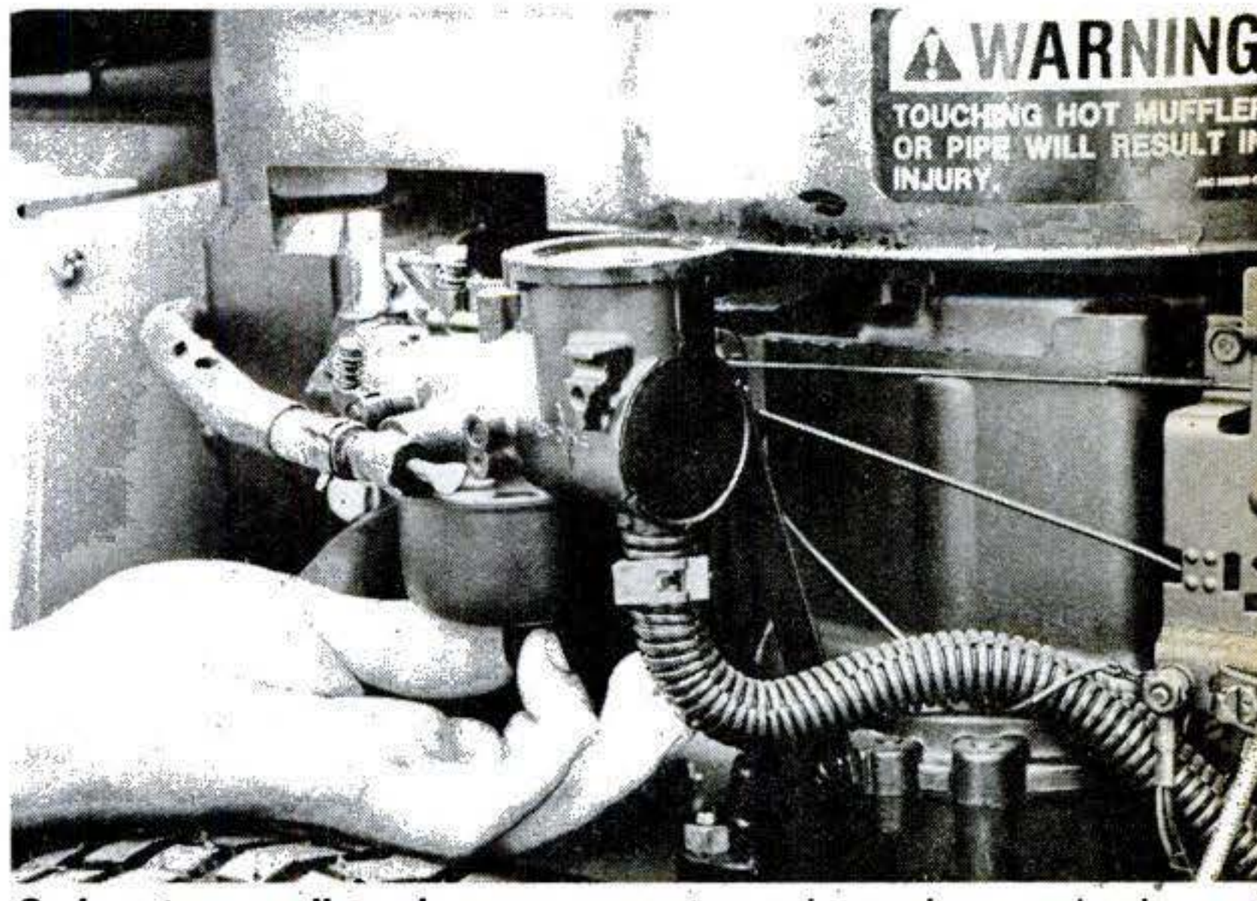
Air-cleaner foam element should be washed in liquid detergent—not gasoline. Squeeze element dry in cloth, then soak it with 30-weight engine oil. Gently squeeze out excess oil.



Easy-to-miss spot is in the fuel cap: Make sure the small hole is not clogged, or gas will not draw from tank. Add fresh fuel. The tank should have been drained before storage, last fall.



Change engine oil after every 25 hours of use. Check oil level after every four hours (when engine is warm). Periodically lubricate steering gear, cross shafts, bushings, and control linkages.



Carburetor needle valve can correct rough-running or dead engine: Turn clockwise until closed, then back 1.5 turns. Warm engine, turn valve in either direction for best running.

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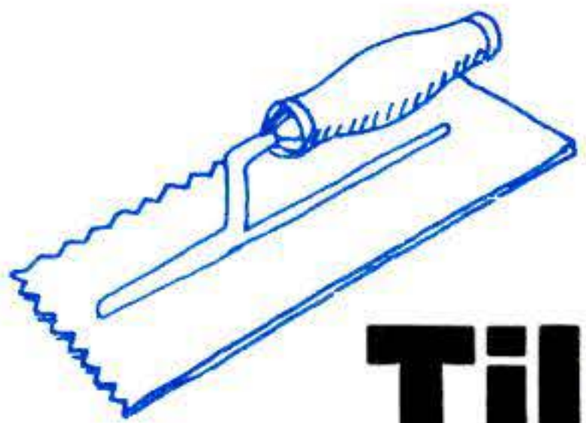
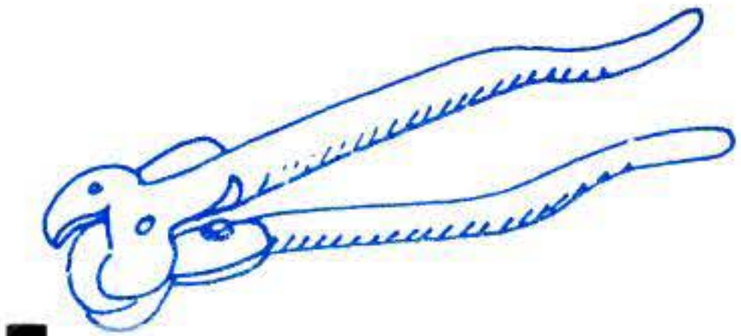
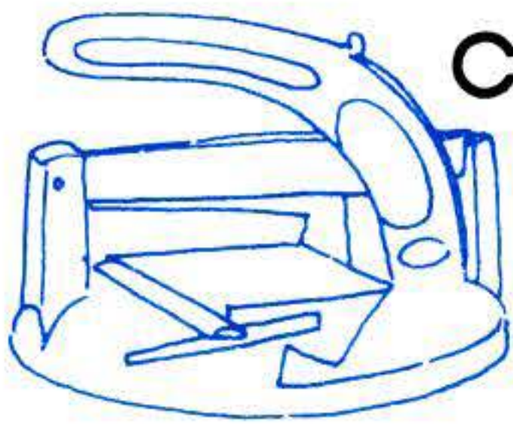
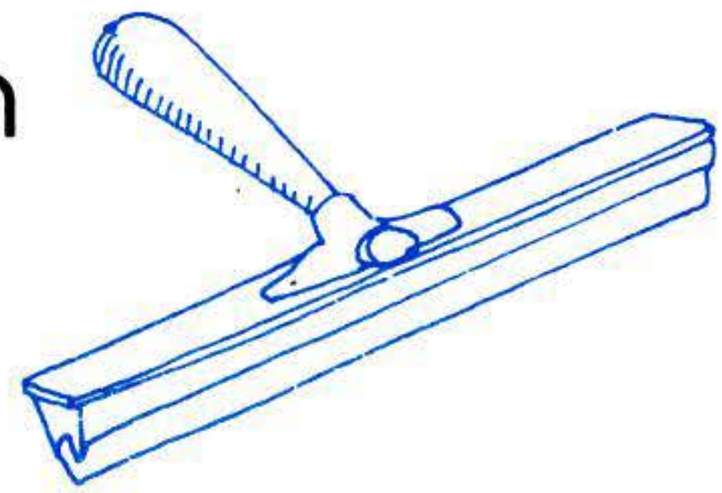




Tiling tricks

customize your bath





You can copy the custom touches that give a bathroom distinction

By AL LEES

You needn't be building a new house to make use of the ideas shown on the next two pages. Most of these features could be included in a bathroom modernization, and would do wonders toward perking up a routine room or bathing alcove.

A major new approach now being promoted by the Tile Council of America greatly expands the potential for bathroom upgrading—and makes it unnecessary to live with an impossible old bathroom any longer: You can tile right over existing tile.

Most of us with outdated ceramic-tiled bathrooms have assumed we're stuck with the pink-and-lavender or chartreuse effects. Tile is such a permanent covering—for walls or floor—that the notion of stripping it all off for a new surfacing treatment lacks appeal.

"Not necessary," the Council now tells us: "Newly developed setting materials let you tile over any surface that's structurally sound—including old tile." *Structurally sound* is the vital phrase here: If your old tiles are loose and the mortar is crumbling, don't risk installing new tile over them. But most tiling jobs—if not subjected to deteriorating moisture conditions from behind—are as sound as the day they were installed.

Preparation work for tiling over tile is minimal. All that's needed is a good cleaning with a strong detergent, plus sanding with Carborundum paper. (Abrasion gives a better bond for the new tile.)

Perhaps your bathroom or bathing alcove is tiled only three-quarters of the way up the wall, but you'd prefer a sleek tile surface all the way up to the ceiling. Just install a panel of wallboard on that exposed upper section of the wall, choosing a thickness to match that of the tiled area below. Then you run the new tile on right over this filled-out base. Once the tile field is grouted, you'll never find the seam.

For any of the special structural effects shown on the next two pages, you may have to knock through old tile to tie your new framing to existing studs or joists. You then face your framing with exterior-grade plywood and apply the new tile to this surface.

Variety: size, shape, color

Another recent development lets you tile these fairly elaborate built-ins with ease and professional neatness: Not only do major tile makers offer a choice of tile *sizes* (as well as colors and textures), but they've added a variety of accessory trim shapes to let you turn corners and cap edges. These ceramic units are just as easy to install as the standard field tiles they match.

For most wet-area applications, it's best to choose a textured, slip-resistant tile, rather than one with a glass-slick surface. As for color choices—don't be timid; the bath is a prime area for indulging your taste for bold colors. This is a room where you spend relatively little time, so heavy concentrations of color won't have a chance to tire the eye. That's one reason why dark earth tones seldom seem oppressive, even when they're used in a small bathroom.

As for the *size* of the tile you choose—it may be dictated by your project. If you plan to face coves with it, for example, only the smaller "mosaic" tiles will give you a smooth curve.

The only special tools you'll need for the job are the four sketched above: a notched trowel (for spreading the adhesive), nippers (for notching tile to fit around pipes), a tile cutter (usually rented from the dealer who sells you the tile), and a squeegee (for spreading grout into the gaps between tiles). From your standard tool chest, you'll need a straightedge, carpenter's level, plumb line, square, measuring tape, chalk line, trowel and wide putty knife, scraper, sponge—and a Carborundum stone for smoothing any cut edges.

For the actual setting of the tile, you can use epoxy adhesives, mastics, or sanded-latex portland-cement mortars. As for grouting materials, there's now a variety of pre-mixed types in a wide range of colors that can also figure into your design.

Always do a dry run before committing yourself to the installation. Using a level and plumb line, draw horizontal and vertical lines across the center of each area to be tiled. Lay out a loose course of tile (no adhesive) and adjust your starting lines left or right, up or down, so the fewest number of tiles will have to be cut along the edges. Always aim for edges that leave at least half a tile. Thin slivers of tile are not only hard to cut—they'll look patchy.

For step-by-step instructions, send 50¢ to Tile Council of America, Box 2222, Princeton, N.J. 08540, and they'll send you a new leaflet titled "How to Tile It Yourself."

Turn page for more tiling tricks

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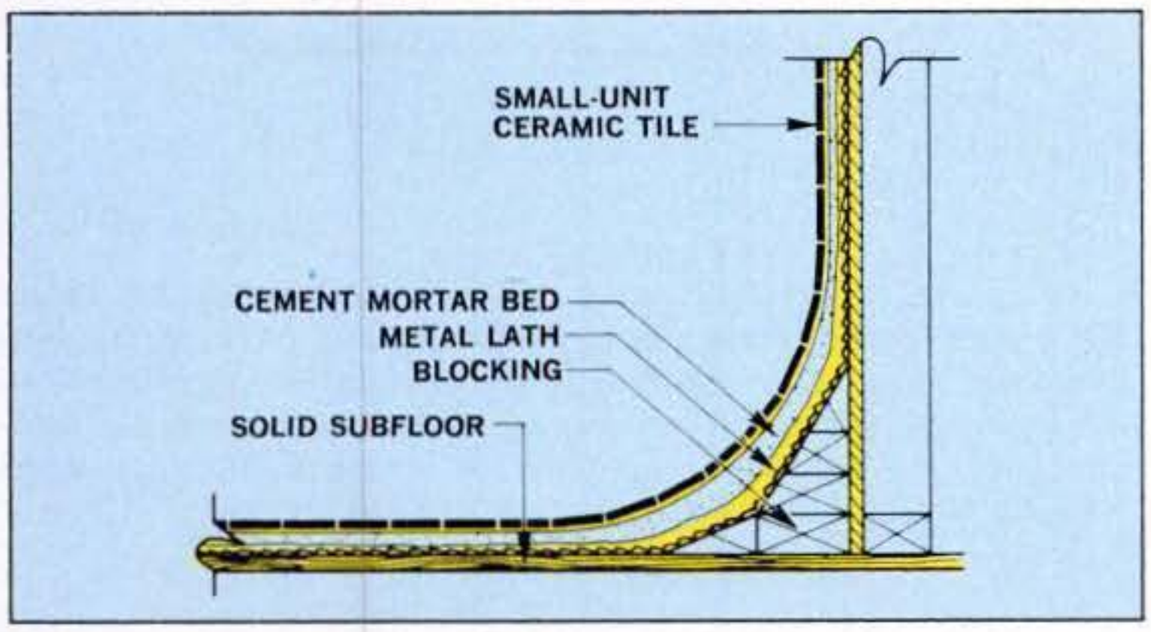
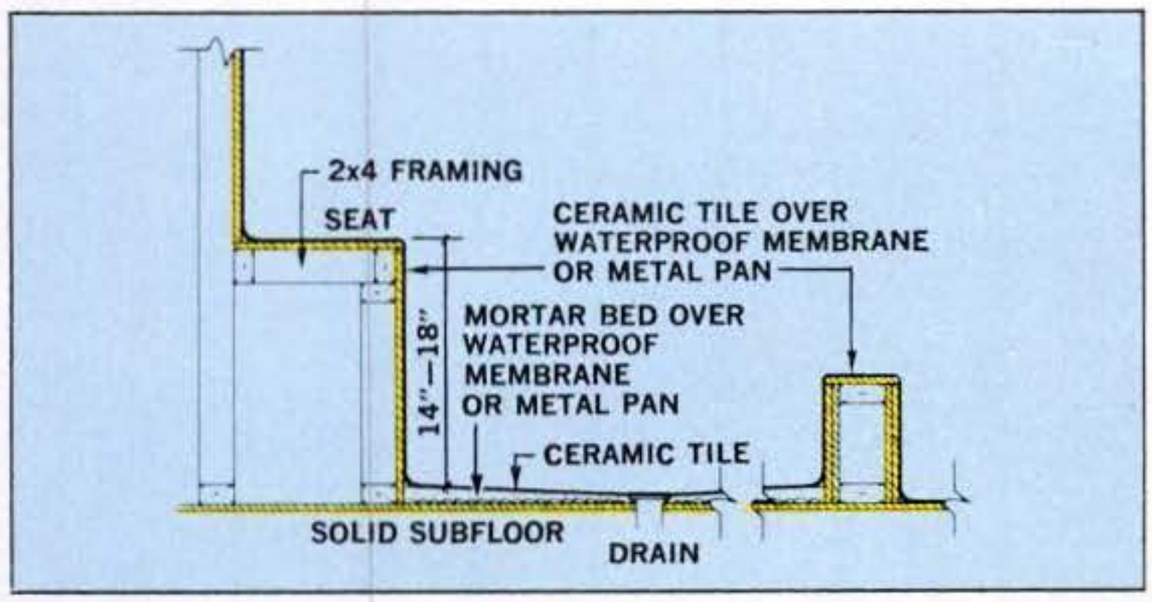


Cove away floor-wall corners—especially in hard-to-clean areas, like under the vanity counter. Small-unit mosaic tile (American Olean's Topaz, here) makes gradual curves possible—with blocking for mortar bed over metal lath, as shown. Curve is echoed where dark stripe turns corner; tile must be shaped for this.



Build in a shower seat for comfort and safety. Since tile will form watertight facing, 2×4's can be used to frame both the bench and the threshold lip beneath the shower door or curtain. In this installation, two-by-two-in. tile is run right over drain pan. Note tiled ledge above seat for holding soaps and shampoos.

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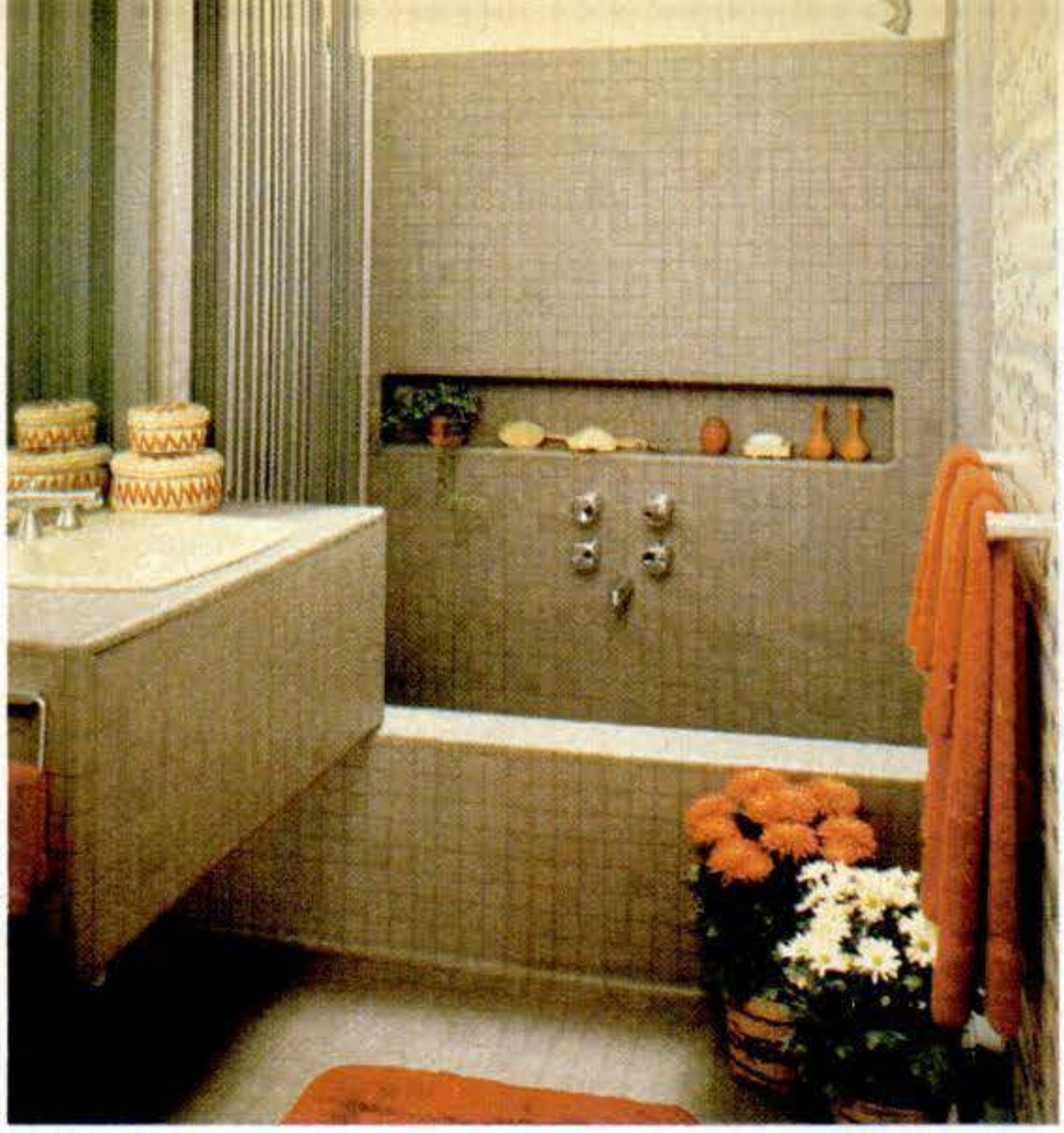
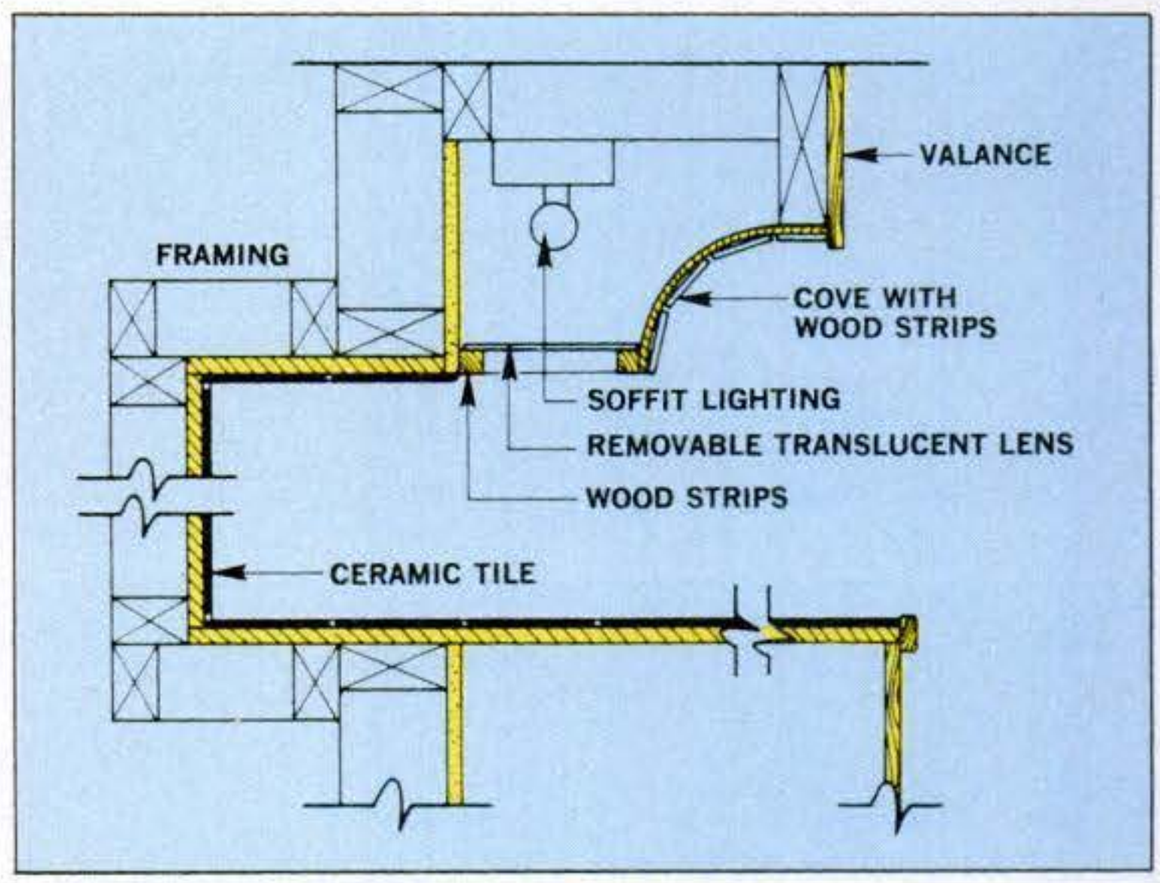


Add a tub-wall niche to eliminate groping for soap, salts, and brushes. If the back wall of your tub recess is a non-load-bearing partition, you can cut across the studs as shown, then deepen the recess by tacking 2×2 cleats to the 2×4's nailed across the cut ends. Tub is formed by tiling over framing and drain pan.



Tile a shelf recess between the mirrors of a two-basin vanity. Run the tile on out across the top of a storage chest snugged between the counters. Glass shelves display folded towels and accessories. Tile, here, is American Olean's Renaissance. Adding a wood valance for soffit lighting makes entire area sparkle.

Create supergraphics with tiles of contrasting colors. Who says all tiles have to be applied in solid-color squares? The alcove shower's Navajo motif requires several two-tone tiles (custom-glazed in two colors); the bold star design requires many specially glazed units. (Both designs by California architect Gary Gilbar.) Simpler patterns can be worked out just by alternating tiles of several colors, or tiles could be cut, corner to corner, with the extra grout lines worked into the design.

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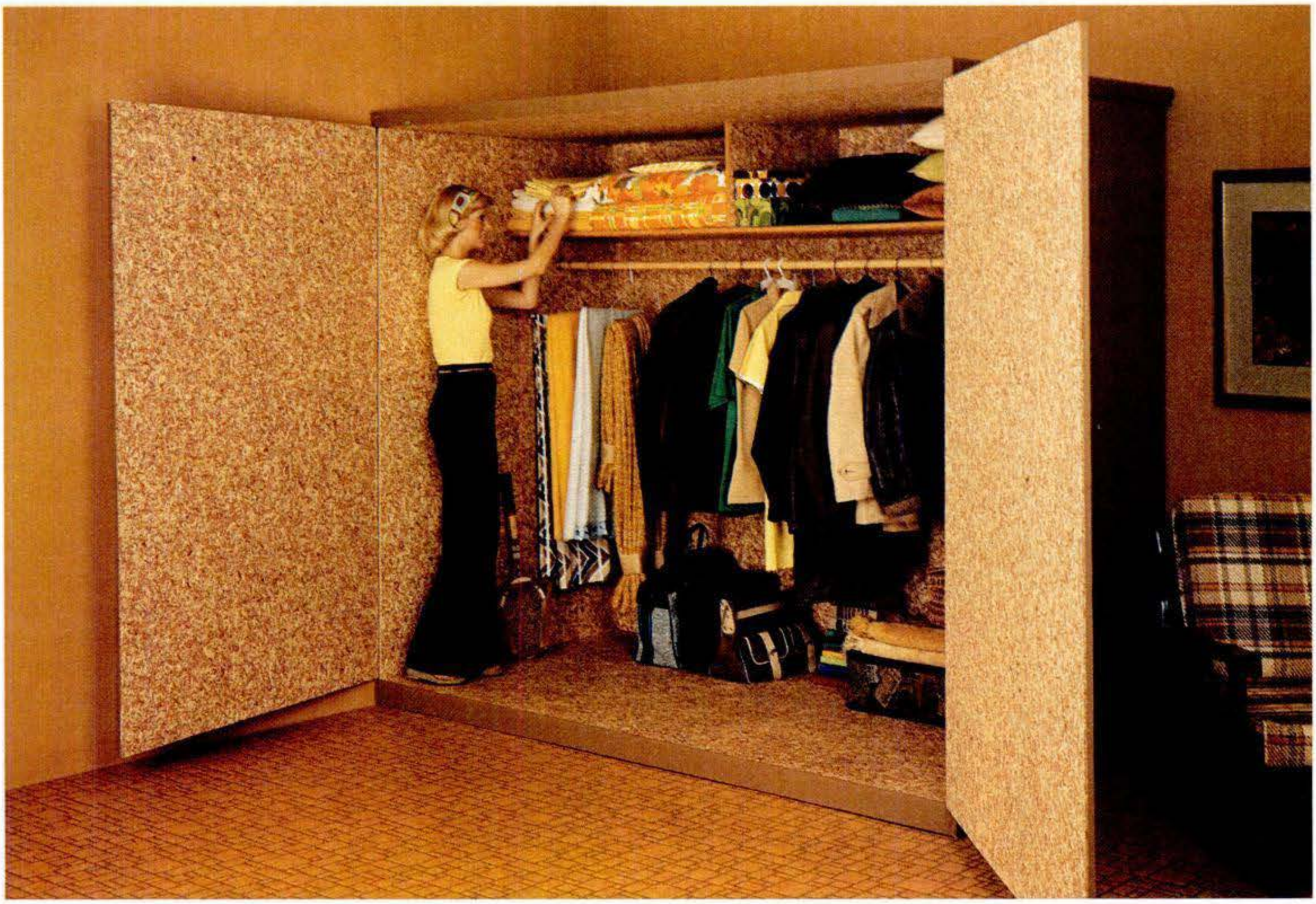


By WILLIAM J. HAWKINS
DRAWING BY GERHARD RICHTER

STORAGE from SCRATCH

Cedar closet
for out-of-season clothes

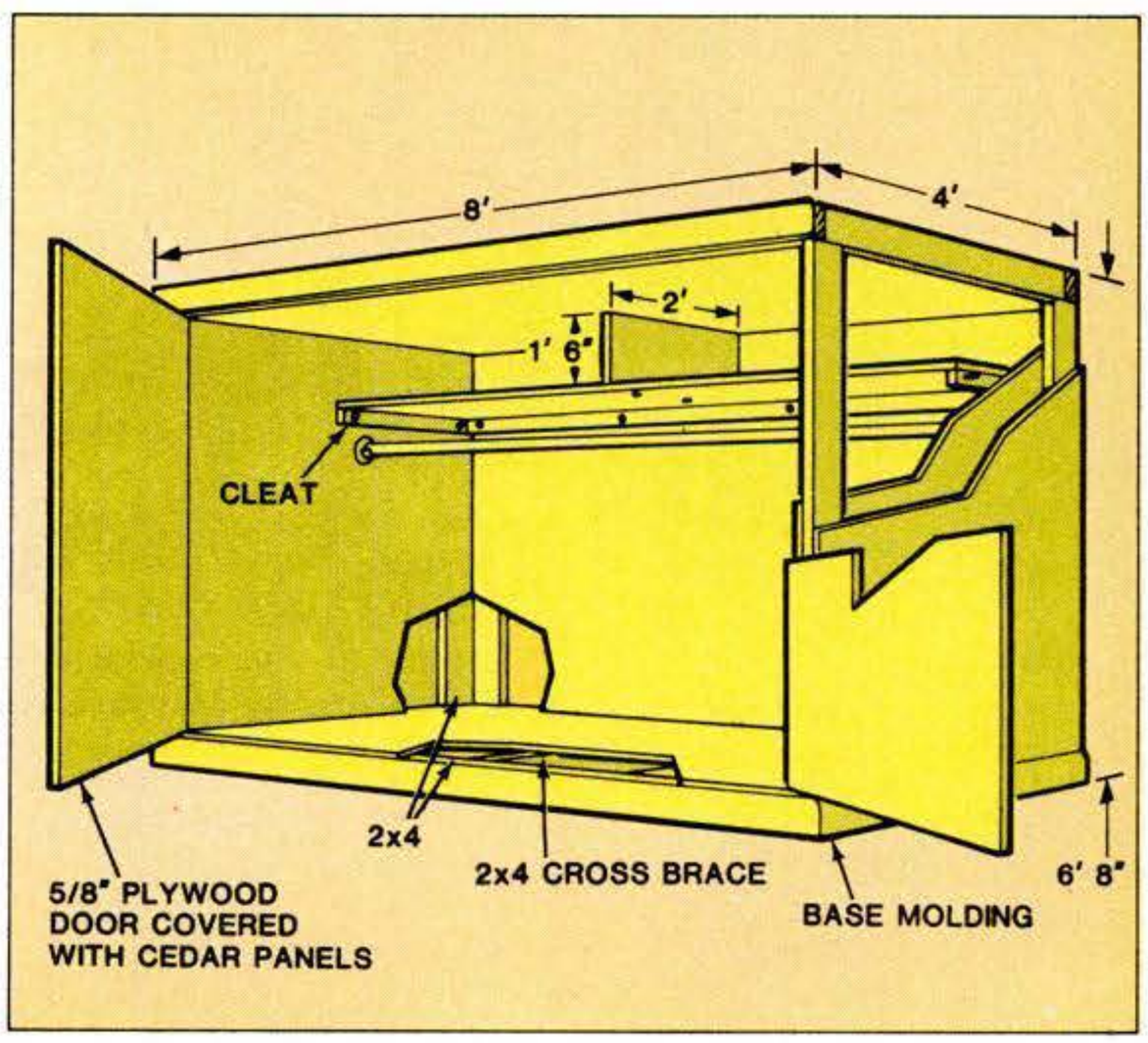
If you stash winter clothes just anywhere for the summer, moths or mildew could mean you'll need a new wardrobe in the fall. The cure is cedar. The natural aroma of the wood smells good to us, but not to flying feeders. It also discourages mildew. And now cedar is flaked and pressed into four-by-eight-foot sheets—no need for the old tongue-and-groove boards that required time and a professional touch to assemble.

The free-standing closet shown is framed with 2×4 stock and covered with ⅝-inch exterior plywood. Nail the ply to the framing in order: floor, sides, back, and ceiling. Then, in the same order, line the closet—plus the door panels—with the cedar sheets, using nails or panel adhesive. The sheets must be cut with a saw—do not try to score and snap. Save the remnants to line shelves. Install the clothes rod at a convenient height.

Finally, add weatherstripping around the doors for an airtight seal. Magnetic catches will keep them closed yet allow them to be opened from the inside for safety. Once complete, don't finish or paint: This would seal the panels, making them useless.

Although a free-standing closet is shown here, it's even easier to construct a built-in cedar closet. For new construction, the panels are nailed or glued directly to open studding (if local building codes permit it). For installation over a finished wall, use 1¼-inch finishing nails spaced every 12 inches vertically at each stud position (usually 16-inch centers).

Cedar panels are available through local lumberyards, and more information—including an idea booklet and a panel sample—is available for 50 cents from Giles & Kendall, Box 188, Dept. 7, Huntsville, Ala. 35804. PS



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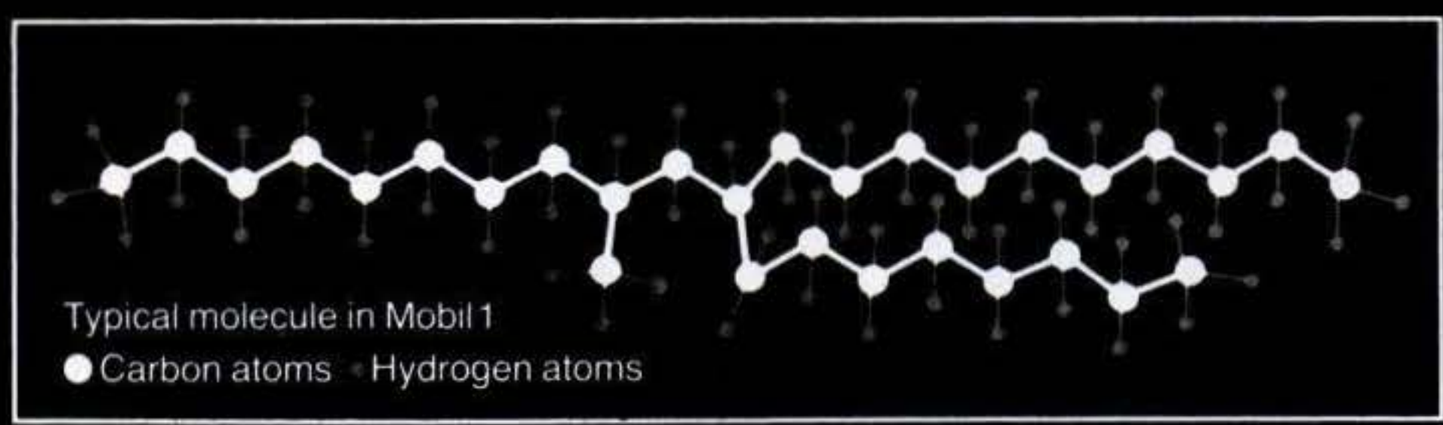
Mobil 1 costs more than Valvoline, Quaker State and Pennzoil put together, because of the way it's put together.

This typical molecule in Mobil 1® is the reason why Mobil 1 lubricates better, cleans better and protects your engine better than conventional oils can.

Conventional oils like Quaker State, Valvoline and Pennzoil are made up of thousands of different molecules of widely varying size, length and shape.

Whenever your engine gets hot, the smaller molecules can evaporate while some of the larger molecules can oxidize and stick to engine parts.

Mobil 1 molecules are "custom built" to just the right length and shape so they stay liquid longer under a wider temperature range.



Typical molecule in Mobil 1
● Carbon atoms ◦ Hydrogen atoms

In fact, Mobil 1 will keep protecting your engine up to 500°F above and it'll help get you started even down at 35°F below.

And Mobil 1's special molecular composition is also the reason Mobil 1 saves gas compared to conventional oil and won't need changing for 25,000 miles (or one year whichever comes first*).

So change to Mobil 1. You can't find a better motor oil, and you can bet your molecules on that.

*Add oil as needed. New car owners follow warranty instructions. Diesel owners follow manufacturer's instructions.

Mobil 1. The oil that saves you gas. And more.

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Beginning here: PS special section on auto maintenance

AUTO MAINTENANCE

Save it or sell it?

With today's high car prices, here's how to evaluate whether your car's worth keeping

By E.F. LINDSLEY and RAY HILL

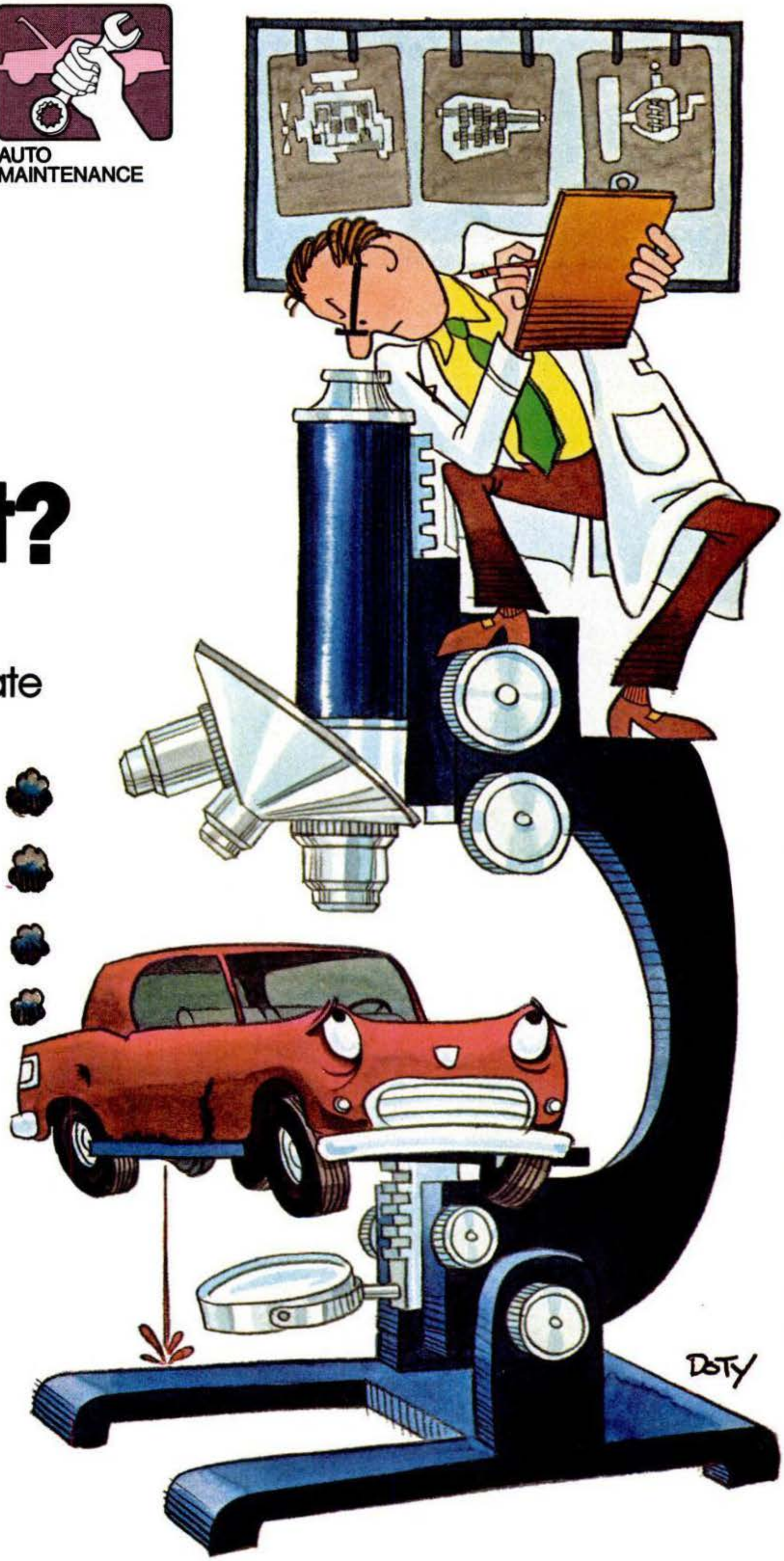
You say your car's worn out? You need a new one but can't afford it? Join the ranks.

Today the price of a new car, any new car, is upward of $5,000. When amenities are included, the cost really skyrockets—to a point where many car shoppers are coming down with "sticker shock." And when you consider double-digit interest rates on loans, it's a wonder anyone can contemplate buying a new car.

That's where your "worn-out" jalopy comes in. Your car, like your house, is a major investment. And just as homeowners are staying put and remodeling their homes, perhaps you should take a close look at your car and spend some time and money on a rebuild. You may be able to return it to its old reliable self.

Don't think of rebuilding, or reconditioning, as a restoration, though. Restoring the rusted hulk of a car to showroom condition is too expensive if all you want is dependable transportation. Rebuilding means starting with a car in reasonably good shape and replacing or repairing the vital en-

Continued



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STOP STALLING. PUT IN AUTOLITE, THE WIDE-HEAT-RANGE PLUG.

If, some mornings, your car refuses to leave the driveway, or hates saying goodbye to stop signs, you may well be the victim of something called "cold plugs."

Poor starting, misfiring, and hesitating are often caused by oil and carbon deposits on the spark plug tips.

To burn these off, you need what are called *hot* plugs.

But, for effortless high-speed running on the highway, you're better off with *cold* plugs. (That's what race cars use.)

So what should you put in your car?

Try putting in, not just new plugs, but a new *brand* of plugs.

Autolite spark plugs. With Power Tips.*

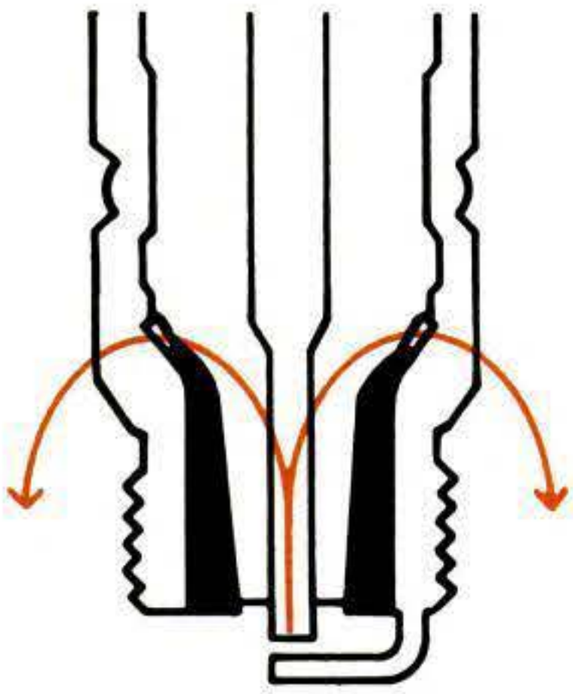
The Power-Tip Autolite is a remarkable plug. It has what mechanics call a *wide heat range.*

Because of its wide-heat-range design it works like two plugs—a hot plug *and* a cold plug.

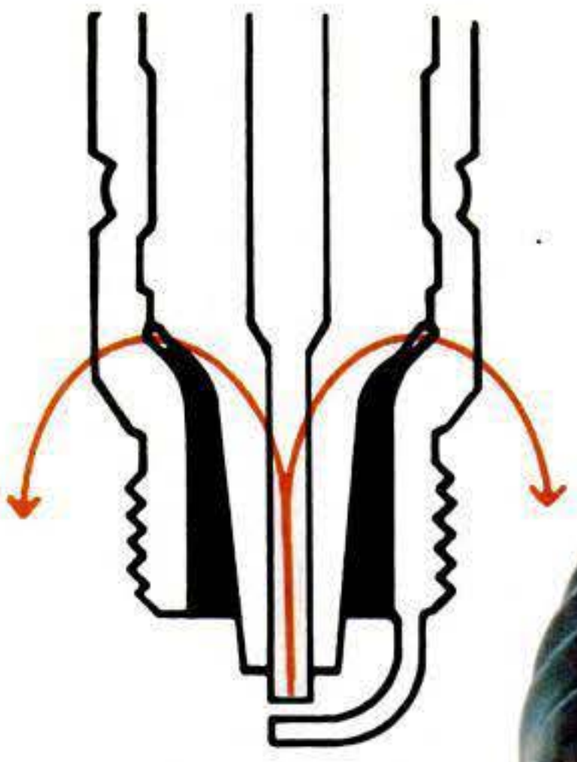
It runs hot on short trips, to burn off carbon, and cold on long trips, for smooth driving.

So if your car stalls or misfires, why hesitate?

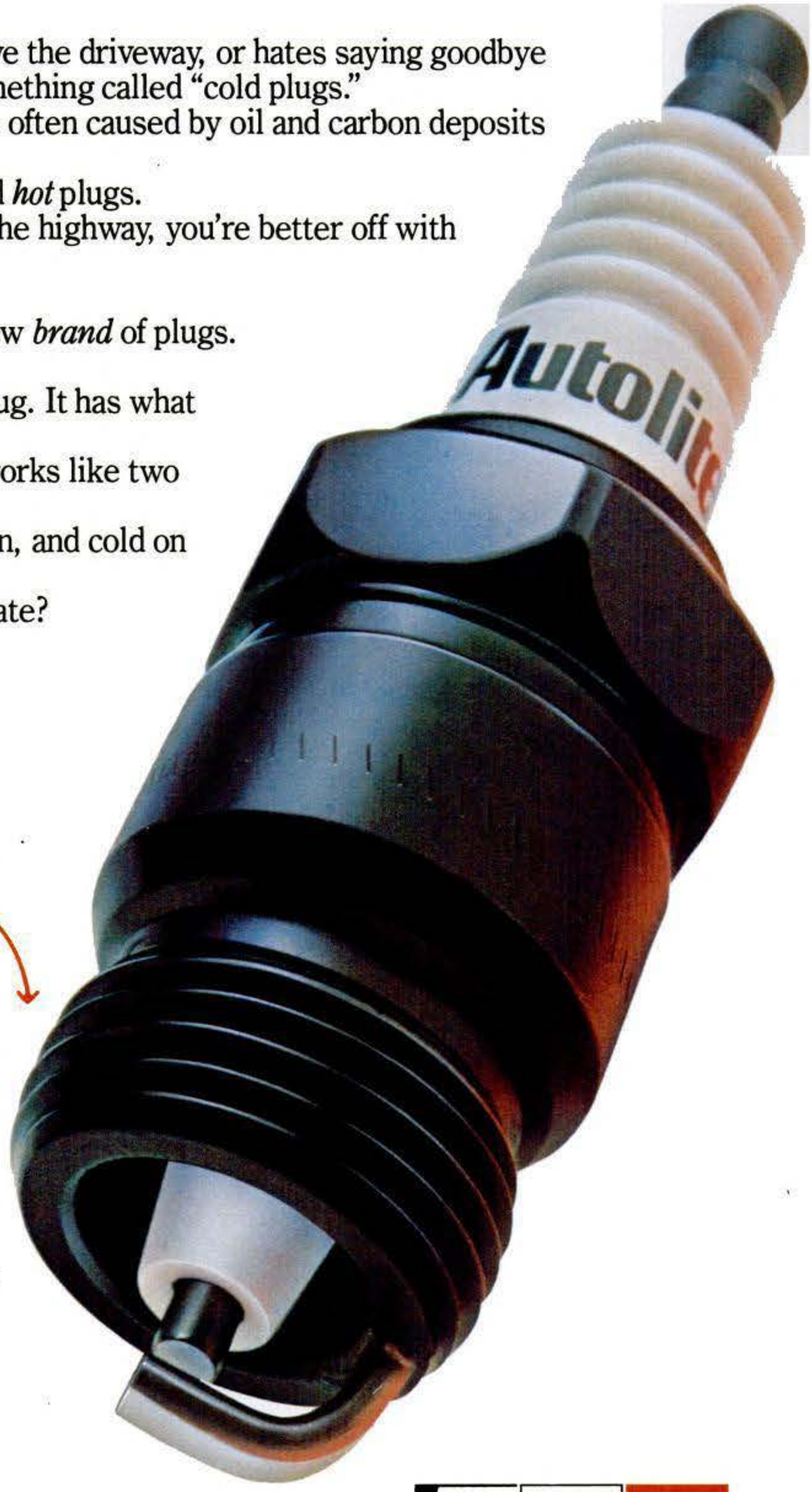
Put in Autolites.



In an ordinary plug, the tip is short, which makes it lose heat faster at low speeds. And, because it's not as exposed to cool intake gasses, it stays hotter at high speeds.



Autolite Power Tip plugs have longer insulators and electrodes. Heat transfers more slowly at low speeds, so carbon burns off. But at high speeds, low-temperature intake gasses keep the tip cooler, to help prevent pre-ignition and overheating.



*Available for cars where space in the combustion chamber is sufficient to accommodate the Power Tip.

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gine, transmission, suspension, and other operating parts so they'll function without trouble for some years to come.

But be aware that you'll be taking a gamble in reconditioning an older car. For example, you may complete what seems to be a good rebuilding job only to have a costly part fail a few miles later. You'll have to balance the costs, gains, and risks to decide if rebuilding is feasible.

On the following pages is a flow chart to help you tally up the pros and cons of reconditioning your car. We've listed all major items you should investigate, along with approximate repair costs. If an item in your car is okay, check GOOD; if it needs repair or replacement, check BAD and note how much it will probably cost. Where we've left out a price, the cost is too variable to make a reasonable estimate. Fill it in according to your specific situation.

There are some basic factors you should consider when deciding whether to rebuild. How much of the work can you handle yourself? What about downtime and interim transportation? Where would you stand if, after an expensive rebuild, you totaled the car and the insurance company paid out only the depreciated "blue book" value? Will you be satisfied with your car's outdated styling for a few more years? How much degradation in your car's appearance are you willing to accept? You must come to terms with all these considerations before committing yourself to reconditioning your car.

Once you decide to continue, take a look at the flow chart. A yes answer to any of the "go or no-go" questions should make you think twice about reconditioning your car; it would probably be a bad investment. But if your car passes this first test, follow the step-by-step procedures detailed in the chart, keeping a running account of costs as you go. And it's a good idea to have a shop manual for your car handy.

The four-mile road test is a good way to start. It will help you quickly discover some of your car's more obvious faults.

Next, give the car a thorough going over, especially underneath with a powerful light. Anyone who has a good set of tools can do most of the inspections we've detailed, and you can rent or borrow some of the equipment you may not have.

Continued

Reconditioning your car: the route to low-cost transportation

Basic "go or no-go" questions

1. Is the car more than 10 years old? ☐ yes ☐ no
2. Does the car have more than 100,000 miles on it? ☐ yes ☐ no
3. Is the car expensive to operate? A seven-mpg car driven 12,000 miles a year will use $2,400 in gas ($1.40 a gallon). ☐ yes ☐ no
4. Is the car expensive to work on? (For example, an exotic foreign car with hard-to-get parts or a domestic car with costly fuel injection or front-drive.) ☐ yes ☐ no
5. Is the body badly rusted—rocker panels, lower door panels, fenders yield to light thumb pressure—or are any of the frame rails or attachments to suspension parts rusted? ☐ yes ☐ no

IF YES

The car is probably not worth considering

IF NO

Take the car on a four-mile stop-and-go road test

A preliminary road test will point up any major problem areas in your car. Attend to these before beginning a step-by-step check.

1. Listen for knocking (internal engine problem or loose transmission); whining (probably a pump noise, say, the power-steering pump); and tapping sounds.
2. Look for excessive smoke: blue smoke comes from oil (bad rings, leaking valve-guide seals); black smoke comes from gasoline (engine running too rich); white smoke is from coolant (coolant in combustion chamber, cracked head or block, bad gasket).
3. Listen to transmission shifting. Automatic should shift without racing; standard should shift without grinding gears or whining sounds, and clutch shouldn't slip between gears.
4. If you don't know whether a noise is in the engine or drive train, stop the car and accelerate the engine.
5. Investigate anything unusual from the road test.

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Inspect the chassis and undercarriage

1. Check the shocks. If a corner of the car bounces more than 1½ times when it's pushed, the shock is bad. Replace in pairs ($15–$35 a pair). ☐good ☐bad $____
2. Check the springs. Look for broken leaves, bad shackles, signs of shifting, worn rubber bushings, broken shock supports, uneven droop between sides and curb heights.
   A. Coil springs cost about $20 each. ☐good ☐bad $____
   B. Leaf springs cost $100 each new, $60 each reconditioned. ☐good ☐bad $____
   C. Torsion bars can be readjusted. n.a. n.a.
3. Check steering linkage (while someone moves the wheel).
   A. Tie-rod ends, center link, idler arm, pitman arm should have no free play. ☐good ☐bad $____
   B. If these are okay but there is still free play, the steering box is bad (manual box: $100 new, $70 rebuilt; power-steering box: $140 rebuilt). ☐good ☐bad $____
4. Inspect all brake lines and hose fittings. ☐good ☐bad $____
5. Check the brakes and wheels.
   A. Drums and rotors must have enough metal to be turned. If not, a drum is $40–$60; rotor, $50–$80. ☐good ☐bad $____
   B. Brake shoes or pads must be replaced if worn ($12 a set). ☐good ☐bad $____
   C. Fading brakes, inconsistent pedal pressure, or leaking master cylinder: Replace master cylinder ($50–$100). ☐good ☐bad $____
   D. Be sure wheel bearings are sound and well greased. ☐good ☐bad $____
6. Inspect fuel-system lines, gauge connections, wires, line supports, and hose connections. ☐good ☐bad $____
7. Check the exhaust system. If it is defective, you can probably hear it. Any rot in the pipes, excessive noise, or cracks should be fixed ($50–$160). ☐good ☐bad $____
8. Inspect all electrical wiring, especially the battery cables and ignition wires. ☐good ☐bad $____
9. Check the "high mortality" parts, such as belts, battery, all hoses, radiator cap, and fuel filter. ☐good ☐bad $____
10. Check the tires. Be sure there's plenty of tread, and the sidewalls aren't damaged. ☐good ☐bad $____

A few of the checks need some explanation, though. In checking the springs, for example, say the car sags to one side. There may be a weak front or rear spring, or two bad springs on the same side. To find out, jack up the front end at the middle until the wheels are a couple of inches off the ground. (Be sure the jack is under a structural member capable of supporting the car.) Measure curb height at the rear. If both sides are equal, you know one of the front springs is bad. Springs, as with shocks, must be replaced in pairs.

Let's say the curb height is still uneven at the rear with the front of the car jacked up. Lower the front end and jack up the rear. Measure front curb height. If it's uneven, both springs on one side are bad; you must replace all four springs. If curb height is now even, both rear springs must be replaced.

When it comes to the engine, things can get more complicated. If your engine has been performing well and your checks of compression, oil pressure, and vacuum raise no red flags, it's probably a pretty safe bet. But you should be aware that in working on complex assemblies, such as the engine, it's easy to be misled—even if you're fairly knowledgeable.

Suppose you have high oil consumption, for example, but compression is at spec. Logic says that all you need are valve seals. But valve seals may be only part of the story. Worn rod bearings may be throwing off more oil than the rings can handle, and the excess oil on the cylinder walls could

Continued

Check the cooling and lubricating systems

1. Pressurize the radiator and look for leaks anywhere on the radiator, heater core, and at all hose connections.
   A. If the radiator core is leaking, it will cost anywhere from $25–$70 to fix, if you can't solder it yourself. A new core will cost $95–up. A new radiator will cost $140. ☐ good ☐ bad $____
   B. A leaking heater core will cost $25–$270 to fix, depending on accessibility. ☐ good ☐ bad $____
   C. Check freeze-out plugs for leaks. Some are hard to get at and may cost, say, up to $100 to fix if the transmission must come out. ☐ good ☐ bad $____
   D. Check condition of antifreeze. Oily, foamy, discolored coolant may signal engine problems; rust suggests some kind of blockage in the system. ☐ good ☐ bad $____
2. Check for engine-oil leaks. Have the engine steam-cleaned and go top to bottom.
   A. Check valve-cover gasket, oil filter, oil-pressure switch, and main crankshaft seal. A leak may be easy to fix (tighten valve cover, tighten oil filter), moderately hard (some valve covers take 90 minutes to remove to replace the gasket), or very hard—and expensive (leaking rear crankshaft seal demands that the engine be removed: over $100). ☐ good ☐ bad $____
   B. If engine oil is milky, coolant is present. Have engine checked at a garage. ☐ good ☐ bad $____
3. Check for transmission-fluid leakage.
   A. Leaking pan gasket or rear seal is easy to repair. ☐ good ☐ bad $____
   B. A leaking front seal is expensive: The transmission must come out. ☐ good ☐ bad $____
   C. If the pinion seal in the differential is leaking, $60 will fix it. ☐ good ☐ bad $____
   D. If there's a leak where the axles fit into the differential housing, you'll need an axle-carrier assembly: $100 used, $75 labor. ☐ good ☐ bad $____
   E. If transmission oil is discolored or it smells odd, have the transmission checked out at a garage. If an overhaul is needed—it probably is—figure on $350–$450. ☐ good ☐ bad $____

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NEW FILTER FOR DIESEL CARS PROTECTS INJECTORS AGAINST WATER DAMAGE

The problem of water in diesel fuel is as old as the diesel engine itself.

And it poses the threat of expensive injector damage to every diesel-powered car and truck on the road.

So it should come as no surprise to learn that virtually every industry expert in diesel maintenance recommends a fuel/water separator to protect your engine.

Water damage to injectors isn't covered by your warranty.

So if your new car is damaged from water in the fuel, you'll have to bear the cost of repair alone.

That's why, for years now, truckers have been using special filters to remove water from diesel fuel. One of the most effective units is the Scavenger from CR Industries. Now, with the growing popularity of diesel cars, CR Industries is introducing the Scavenger III—a special fuel/water separator for automotive diesel engines. But to fully appreciate the importance of the Scavenger III, it helps to fully understand the problem.

Water murders diesel engines.

First, believe it or not, water promotes the growth of algae in your fuel tank. And algae gums up everything. Normally, it'll plug your fuel filter before it gets to anything else. So if your fuel filter is easy to replace, things aren't too bad. But if the water gets to your fuel injection unit, things get worse.

Your fuel injection unit is a masterpiece of micro-technology that depends on diesel fuel for lubrication. But water strips away that vital lubrication causing harmful wear. Worse yet, it causes rust. Before long, internal injector surfaces which are polished to within a few millionths of an inch become badly damaged. A complete injector system overhaul can cost as much as $1200 or more. (And that's no joke.)

COALESCING FILTER MATERIAL CAPTURING WATER DROPLETS.

Diesel fuel: The perfect water trap.

Water has never been a major problem in gasoline. You see, gasoline is so volatile it gives off fumes which form a natural vapor barrier. (When you open a gas tank, air doesn't rush in; fumes rush out.)

But diesel fuel is far less volatile. So in a diesel fuel tank, the air space is filled with ...well ...air. And air usually has a little humidity. When it condenses out, it runs down into the fuel, drops through the fuel (because it's heavier), and settles at the bottom of the tank. The water can't evaporate again because the diesel fuel seals it from the air. Hence, diesel fuel forms the perfect water trap. But for the life of your engine, the water has to come out. Which is where the Scavenger III comes in.

Three-stage filtration.

When water and fuel enter the Scavenger III, they're forced to pass through a remarkable three-stage filtration system.

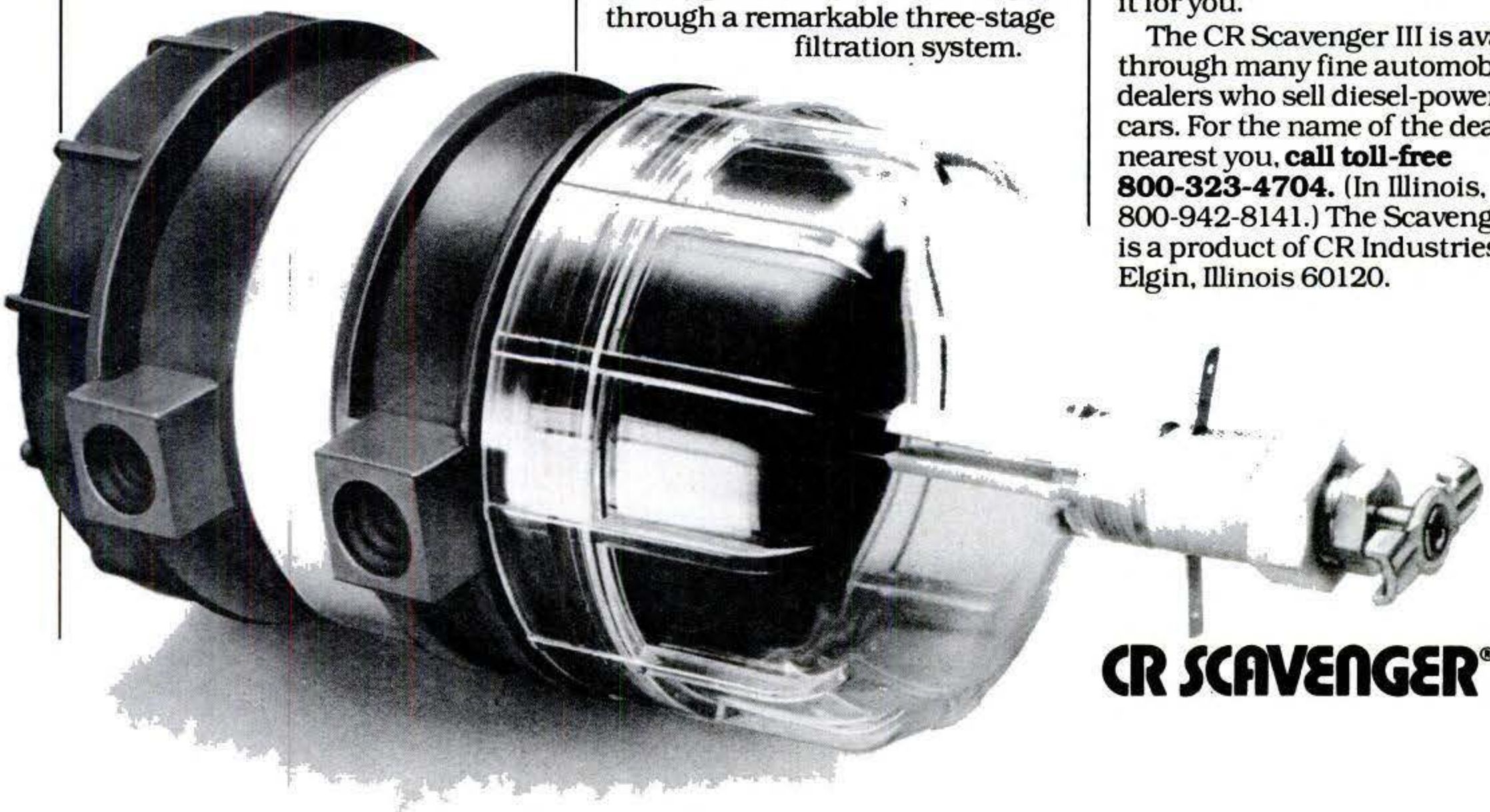
First, a particulate filter removes dirt, grit and algae which could damage the delicate moving parts in a fuel injection system. Next, a unique coalescing filter gathers tiny droplets of water into larger, heavier drops that fall into the reservoir below. Finally, a DuPont Teflon® stripping screen captures any water droplets carried along by rapid fuel flow and forces them to drop into the reservoir.

Drain it while you drive.

The Scavenger III Deluxe Kit includes an electronic water probe which lets you know (through a dash-mounted warning light) that the Scavenger III needs draining. And a remote controlled solenoid valve permits you to drain water from the reservoir without leaving the driver's seat. There isn't another unit on the market which offers this important convenience.

If you're handy with tools, you can install the entire system on your car in an afternoon. (Complete instructions are included.) Or if you prefer, your dealer can install it for you.

The CR Scavenger III is available through many fine automobile dealers who sell diesel-powered cars. For the name of the dealer nearest you, **call toll-free 800-323-4704.** (In Illinois, 800-942-8141.) The Scavenger III is a product of CR Industries, Elgin, Illinois 60120.



CR SCAVENGER® III

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Inspect the power system

Best bet: Have the engine checked with an analyzer, such as Sun's 2001 unit, for a thorough report ($25). If you do it yourself:

1. Check compression [PS, Sept. '81] with a compression gauge. If it's low in one or more cylinders, you have either bad rings or bad valves. Squirt some oil in the bad cylinder.
   A. If the reading is higher when you recheck, rings are bad (ring job: at least $400). ☐good ☐bad $____
   B. If reading is the same, valves are bad (valve job: $200 or more). ☐good ☐bad $____
2. Check oil pressure by removing the oil-pressure switch and inserting a gauge. If oil pressure is not at spec, the cause may be bad bearings or oil pump. Take the car to a garage. ☐good ☐bad $____
3. Check engine vacuum with a vacuum gauge, engine at operating temperature. Vacuum should be 17–21 in., needle steady.
   A. If it's low, you may have a vacuum leak or late timing. ☐good ☐bad $____
   B. If it's erratic, you may have a valve-train problem: bad camshaft, push rods, or rocker arms. You should pull the head and check rocker shafts, rockers, valve springs, cam lifters, and valve timing. Check bores for wear at upper end. ☐good ☐bad $____
4. Perform a power-balance test. Attach a tachometer and, with the engine at operating temperature and running at recommended idle speed, disconnect each spark plug momentarily and watch rpm drop. It should be the same for each cylinder. If not, you probably have an ignition, compression, or vacuum-leak problem. (On some Ford cars, the car must be stopped and restarted for each cylinder.) ☐good ☐bad $____
5. Check the carburetor. If your car is more than five years old you may need a new ($145–$175) one. ☐good ☐bad $____
6. If you decide you need a rebuilt engine, you can either rebuild it yourself or get a salvaged engine (if you have the tools), or buy a re-manufactured one (short block: $640–$1,065 depending on size; full engine: $850–$1,385). ☐good ☐bad $____

What will it cost?

Go back to the chart and tally up all prices attending the "bads" you have checked. Prices not listed can be estimated from the *Motor Parts and Time Guide* for your specific problem. Include labor for whatever you don't, or can't, handle. Fill in the blanks below to obtain comparative costs (say, over three years) for your car versus a new one. For example,a 10-mpg car with $300-a-year insurance (no collision) will cost you $5,940 ($5,040 in gas + $900 insurance) plus rebuild costs. A 25-mpg new car that costs $7,000, has finance charges of $1,152 (on $5,000 over three years), and is insured at $500 a year (collision) will cost you $11,668 ($7,000 + $1,152 + $1,500 + $2,016 in gas).

YOUR CAR		NEW CAR	
rebuild costs (your estimate)	$____	cost	$____
insurance (no collision)	$____	finance (14%)	$____
fuel (X mpg, 12,000 miles a year, $1.40 a gallon)	$____	insurance (collision)	$____
total	$____	fuel (X mpg, 12,000 miles a year, $1.40 a gallon)	$____
		total	$____

be fooling your compression gauge.

In this case, replacing the seals wouldn't help much. A pressure gauge in the oil-sender hole would probably tell you about the worn bearings—but maybe not. A low oil-pressure reading might be no more than a stuck relief valve in the pump or a plugged oil-pump intake screen. It can also mean a worn-out oil pump. You have to be careful not to jump to conclusions.

There are other engine conditions that could badly mislead you. A low or erratic vacuum reading can mean bad valves, but with mechanical lifters it may mean only improper clearance adjustment. A leaking intake manifold or carburetor gasket could be the cause, as well. So might worn rocker bushings, rocker shafts, or adjusting screws. It could also be worn cam lobes, in which case a real check requires at least a dial-indicator reading of each cam lifter.

If you come across a problem such as this, it would be best to seek a professional opinion: It may be a whistle stop for considered judgment before continuing your rebuild.

We have not included appearance items in our flow chart—they have little to do with a car's dependability. But a thorough surface cleanup may make you feel better about your car. If your trim or bumpers are rusted or damaged, trim strips and rechromed bumpers are worthwhile if you can buy them at reasonable cost.

Small dents can probably be repaired with some body filler and a little hard work. But collision damage, such as buckles and ripples, suggests misalignment. You may not want to recondition a car with this damage.

Some climates are hard on paint. Try cleaning up a few spots with rubbing compound: Maybe a professional rub-out with a power buffer would do wonders. And try to work out a systematic spring-fall waxing plan. If severe salt is a problem, spray chrome surfaces with one of the materials that leave a film you can wipe off with a solvent in the spring. Finally, a $150–$200 paint job might be worth it to you, especially if your car is in good mechanical condition and a rebuild isn't that costly.

Deciding whether to save or sell your car is a difficult task. But if you follow through from preliminary evaluation to a system-by-system check-out, you should be able to make a good decision. And if you can save your car, that will be an effective antidote for sticker shock. ■

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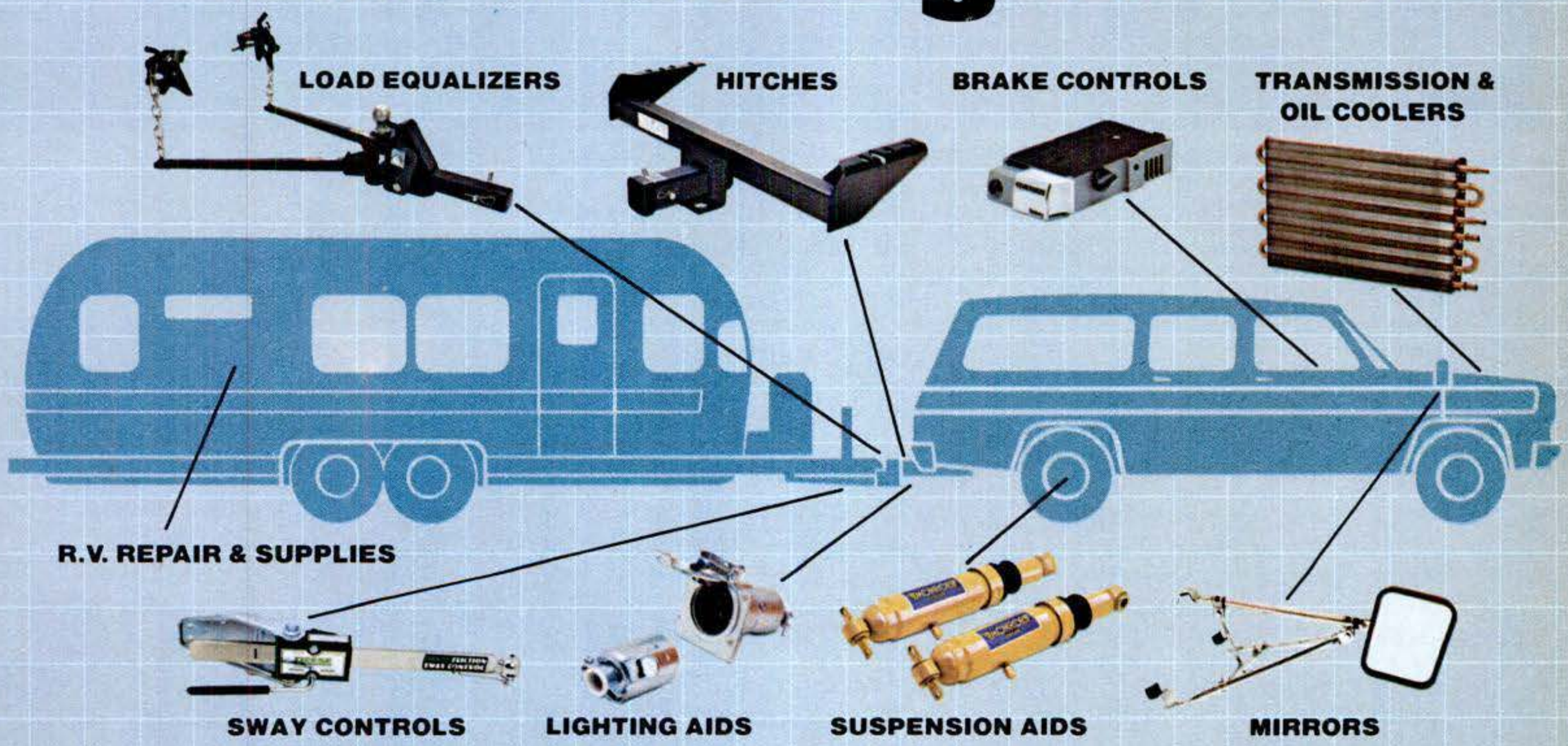
Everything for Your Towing Needs



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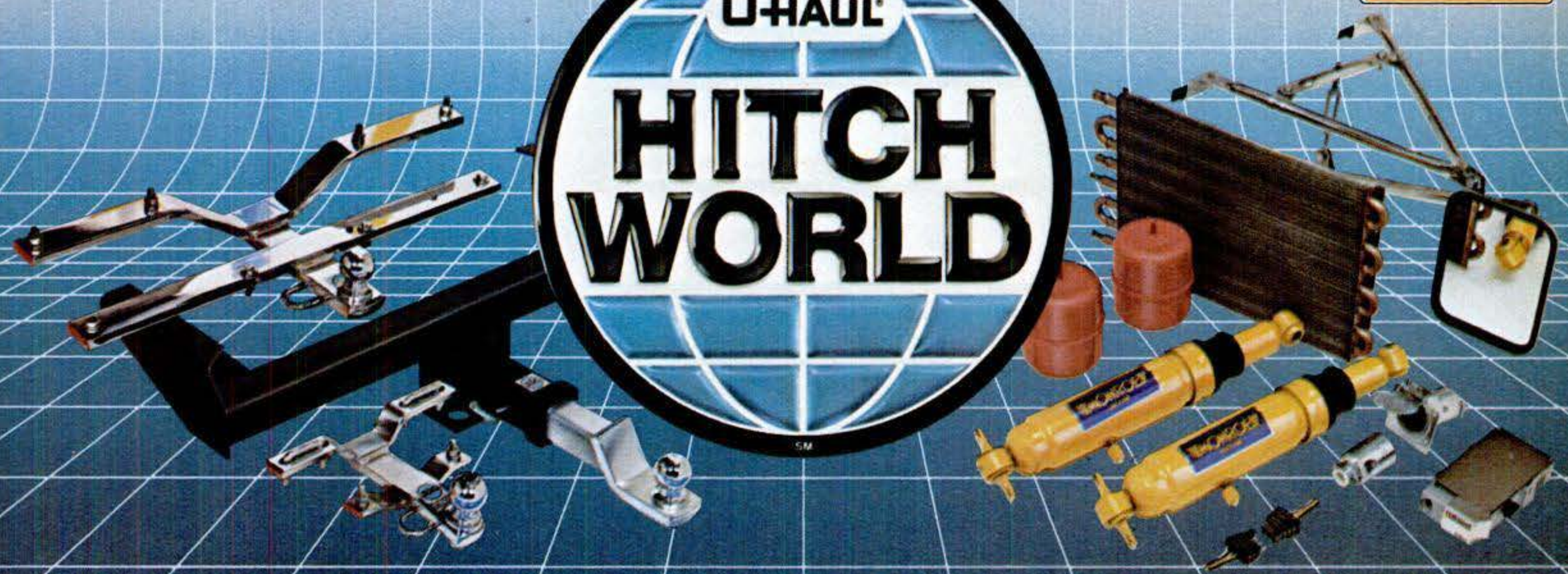

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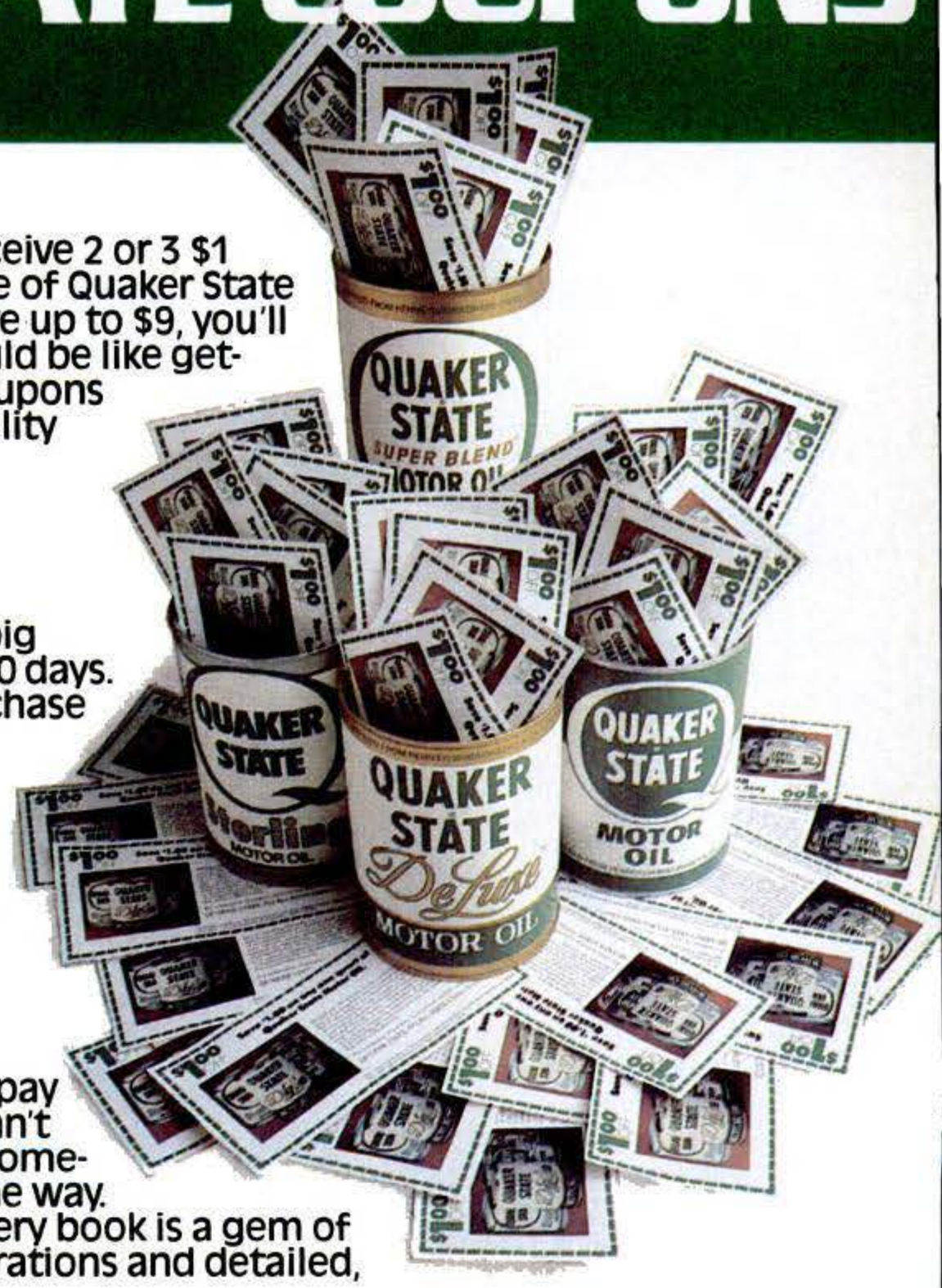

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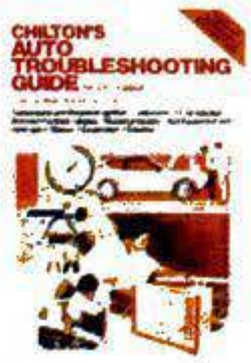

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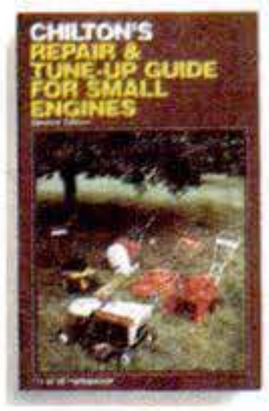

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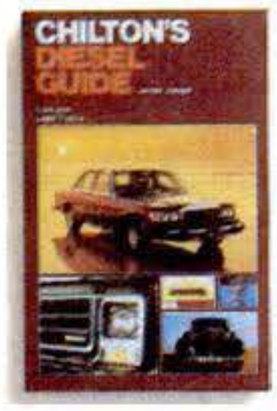

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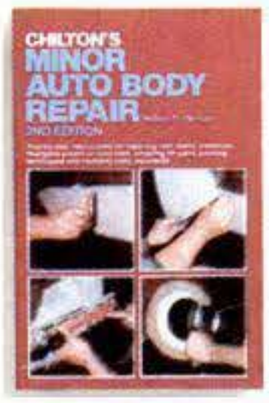

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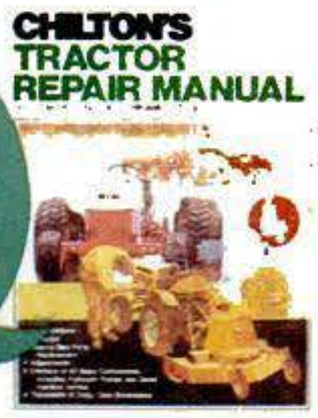

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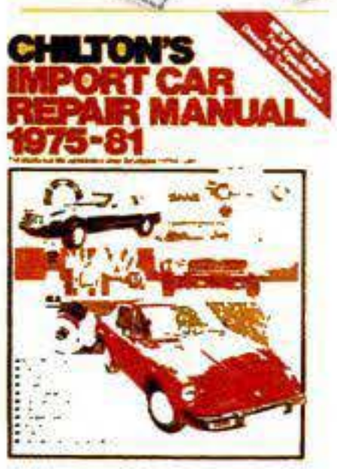

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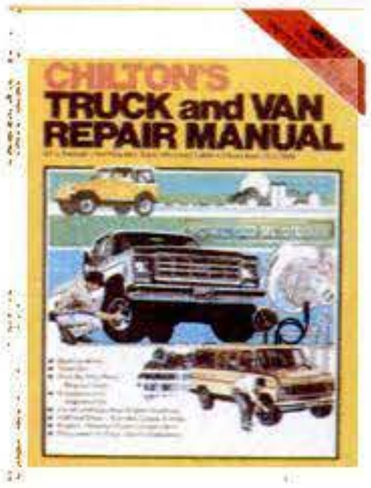

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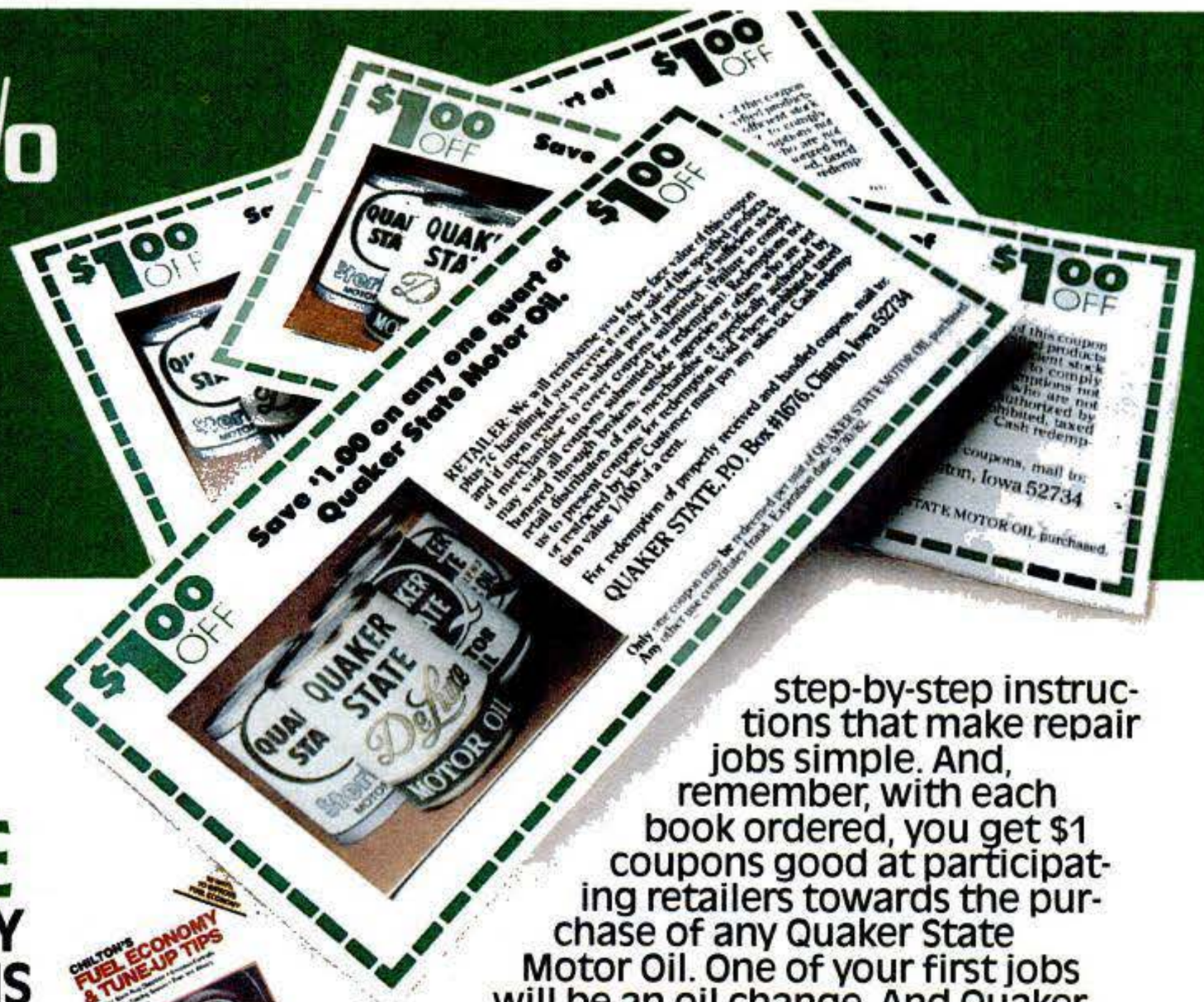

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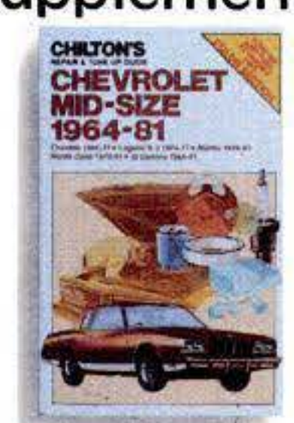

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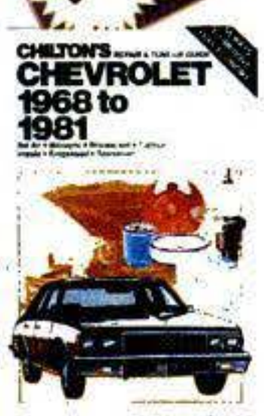

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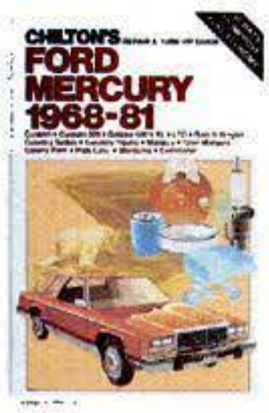

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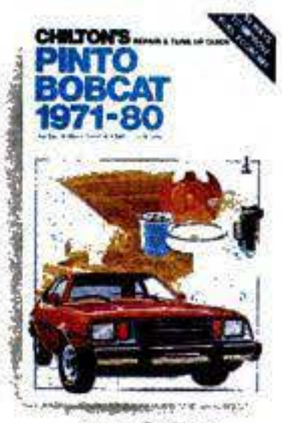

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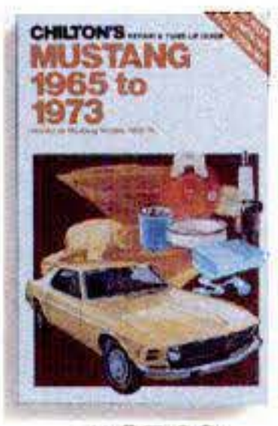

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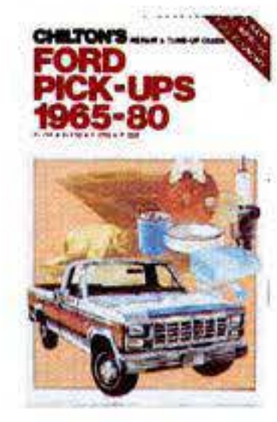

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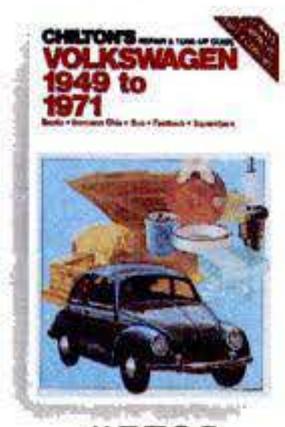

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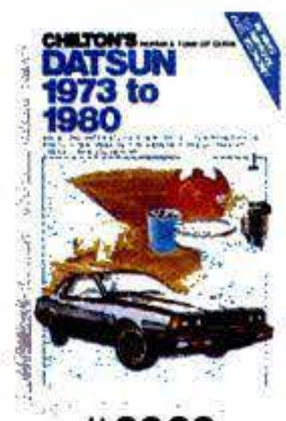

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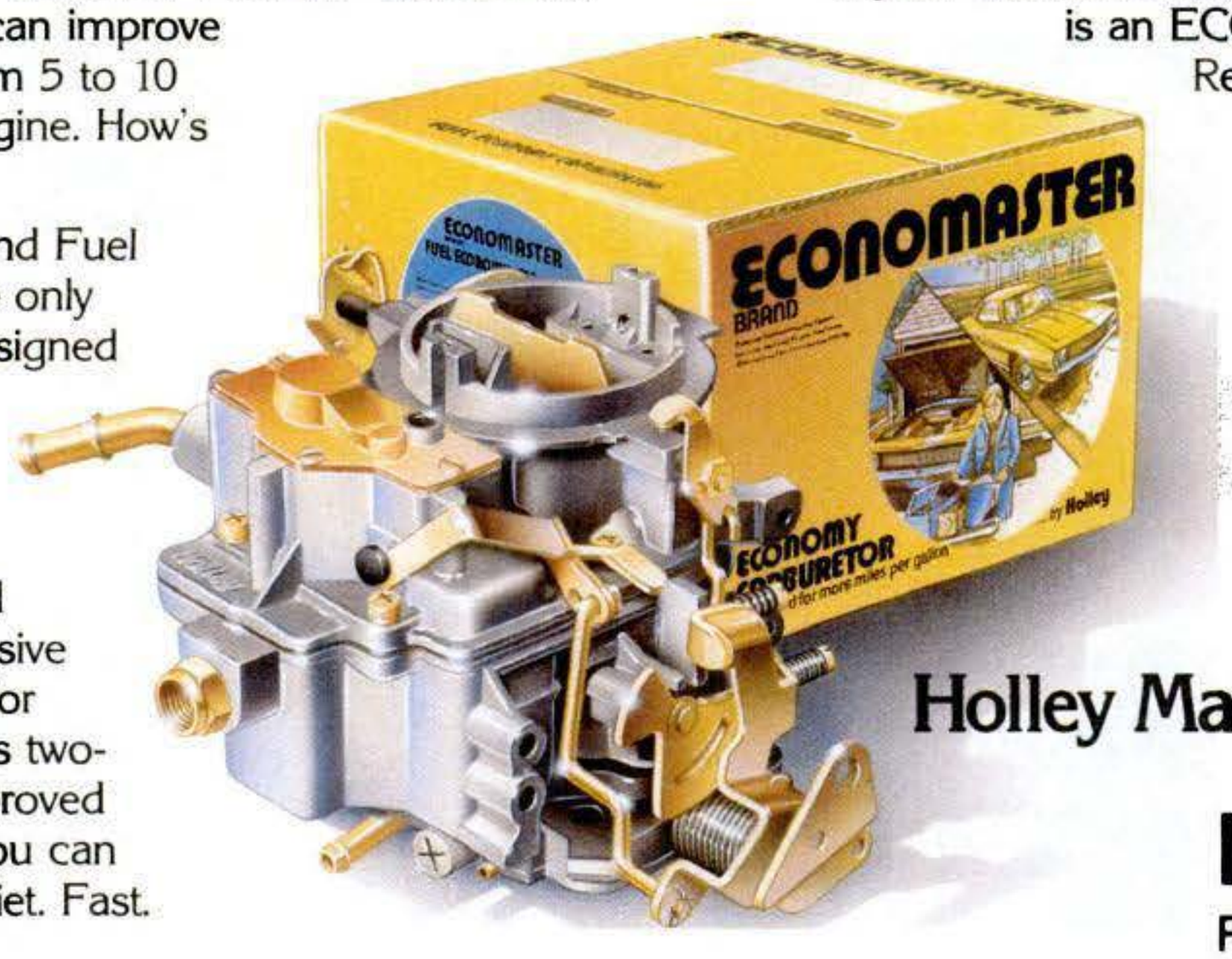

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Electronic add-oil alarms

Checking your oil level from the driver's seat can be as easy as looking at one of these three monitors (left to right): 3M Co.'s Oil Sentry, Normark Manufacturing Corp.'s Electronic Dipstick, and Levelonics' unit, also called Electronic Dipstick.

Not checking your oil? Engine failure can result. These devices will do the job for you

By ED JACOBS
PHOTOGRAPHS BY JOHN KEATING

Many of today's car owners neglect to check the engine oil at frequent intervals, even though the consequences can be extremely expensive.

Why? "Full-service" gas stations are dying out, and, to save money, more and more people are pumping their own fuel at the burgeoning self-service stations. That can mean trouble. Often they forget to check the oil; some don't even know how.

With engine failure a possibility, checking oil level is a must. But it can be a nuisance. Wouldn't it be nice if you could check it from the driver's seat? You can if you drive a new Rolls-Royce, Bentley, Renault 18i, or Ferarri Mondial 8; all of these luxury cars have electronic oil-level monitoring systems.

But even if you don't have a new Rolls, you needn't feel left out. New add-on electronic devices will watch your oil level for you.

While the electronic monitors are new, add-on mechanical systems using vacuum pressure have been around for a long time. According to Don McLees, president of Levelonics and designer of a vacuum system, "Mechanical systems ask too much of the user. To get really accurate readings, you have to use them under the same conditions and operate them the same way every time."

That's not the case with the electronic units. Once installed, they do all of the work, quickly telling you if the oil level is safe. But they don't tell you anything about the oil's *condition*. You should regularly examine the oil on the electronic probe that replaces the dipstick in these systems.

Four types of sensing systems are used: inductive-float, float-switch, thermistor, and conductance-measuring. The inductive-float type (Levelonics Electronic Dipstick) uses a small ball, light enough to float on the oil's surface inside the device's hollow probe. A small coil is located in the probe at the one-quart-low level. When the oil drops to this level, the coil detects the ball's presence and switches on the warning light on the dash.

The float-switch sensor (Useco Engine Saver and Hayden Qt/Low) also uses a lightweight floating ball in a hollow cylinder. When the oil level drops to the add point, the ball touches two electrical contacts and completes a circuit, lighting the warning light.

The thermistor type (Normark Electronic Dipstick) uses engine oil as a heat sink. When the oil falls below the add level, it no longer cools the thermistor; the resulting high-heat condition trips the warning circuit.

The conductance-measuring sensor (3M Oil Sentry) uses a "bistable electronic circuit" as a simple memory and compares the oil's conductance at the checking time with what it "remembers" as the correct value. When the oil level is too low, the two values differ and the warning light is switched on.

Because much oil is drawn out of the sump and circulated through the engine when it is running, these systems are designed to check oil level with the engine off and your vehicle on level ground. However, the Levelonics unit can be left on continuously.

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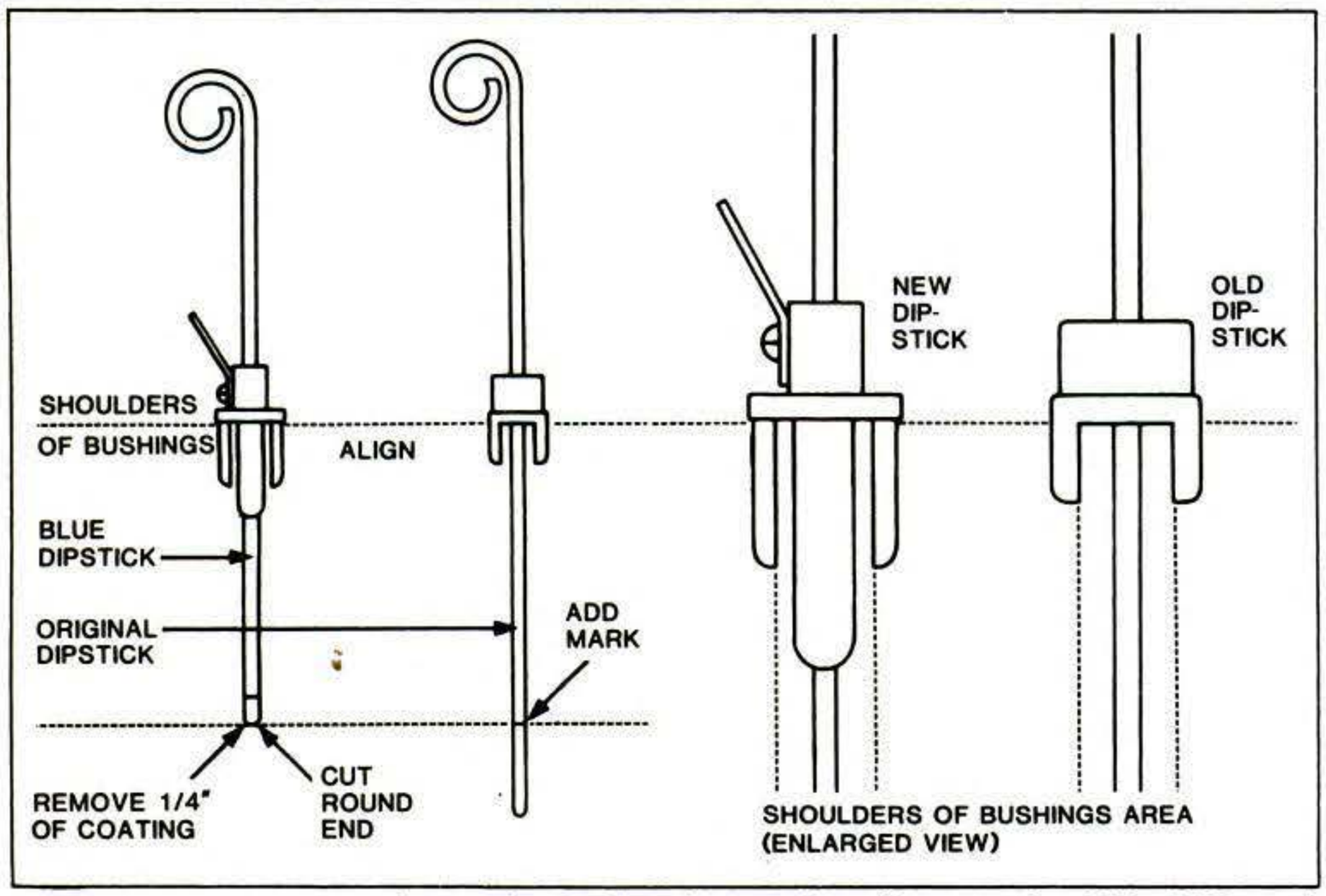
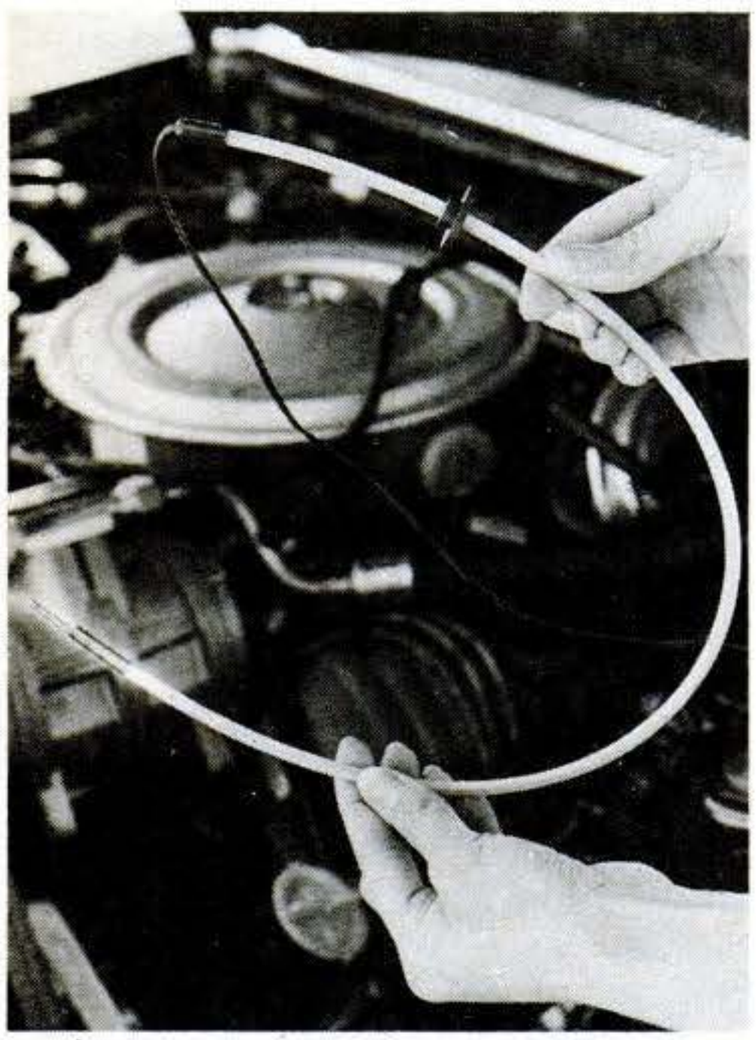


Sensor probes in most of the units available must be tailored so that the sensing elements are lined up with the add-oil mark of the old dipstick. Follow the instructions (these are for 3M's Oil Sentry) scrupulously and exercise great care, as the sensing elements and wiring of probes can be extremely delicate.



Dipstick-replacing probes, such as this Levelonics Electronic Dipstick unit, can also be used as a manual dipstick to check the condition of the engine oil.

"The experienced user," says Don McLees, "can tell about how much oil is in the sump by the way the indicator lights react to changing conditions—hills, curves, braking." Useco president Tom Wilson says that the Engine Saver can be wired to function the same way, "if you want to watch the light show."

Installing the devices can be relatively easy, but some may require drilling and filing if you want to mount their warning panels in your dash or console. Others may require you to gain access to the ignition switch, which can be difficult on newer cars. If possible, try to evaluate a unit's difficulty of installation before you buy it.

Other things to evaluate before purchase include whether or not the unit is fail-safe. (If a component fails, will you get an erroneous "danger" reading or some other warning to make you look for trouble, or will the unit do nothing, leaving you thinking all's well?) Is the system rugged enough for the use *you* will put it through? The Normark sensor, for example, is "very fragile" and carries the warning, "Do not touch with anything." Some probes can also be used in automatic or manual transmissions. Can yours? And can the system operate in the temperature range you have in mind? Most thermistors, for instance, work only between about 25 and 300 degrees Fahrenheit.

Pricing runs from $14.95 to $39.95. That may seem like a lot of money to people who figure that every car comes equipped with a perfectly good dipstick. However, that's true only if you use it. If not, one of these electronic monitors could be the cheapest insurance you can buy for your engine. PS

MANUFACTURERS' LIST

Hayden, Inc. (Qt/Low), 1531 Pomona Rd., Corona CA 93111; **Levelonics (Electronic Dipstick),** Box 5667, Everett WA 98206; **Normark Manufacturing Corp. (Electronic Dipstick),** Box 400408, Dallas TX 75240; **3M (Oil Sentry),** Box 33133, St. Paul MN 55133; **Useco (Engine Saver),** 4949 Everett Ave., Los Angeles CA 90058.

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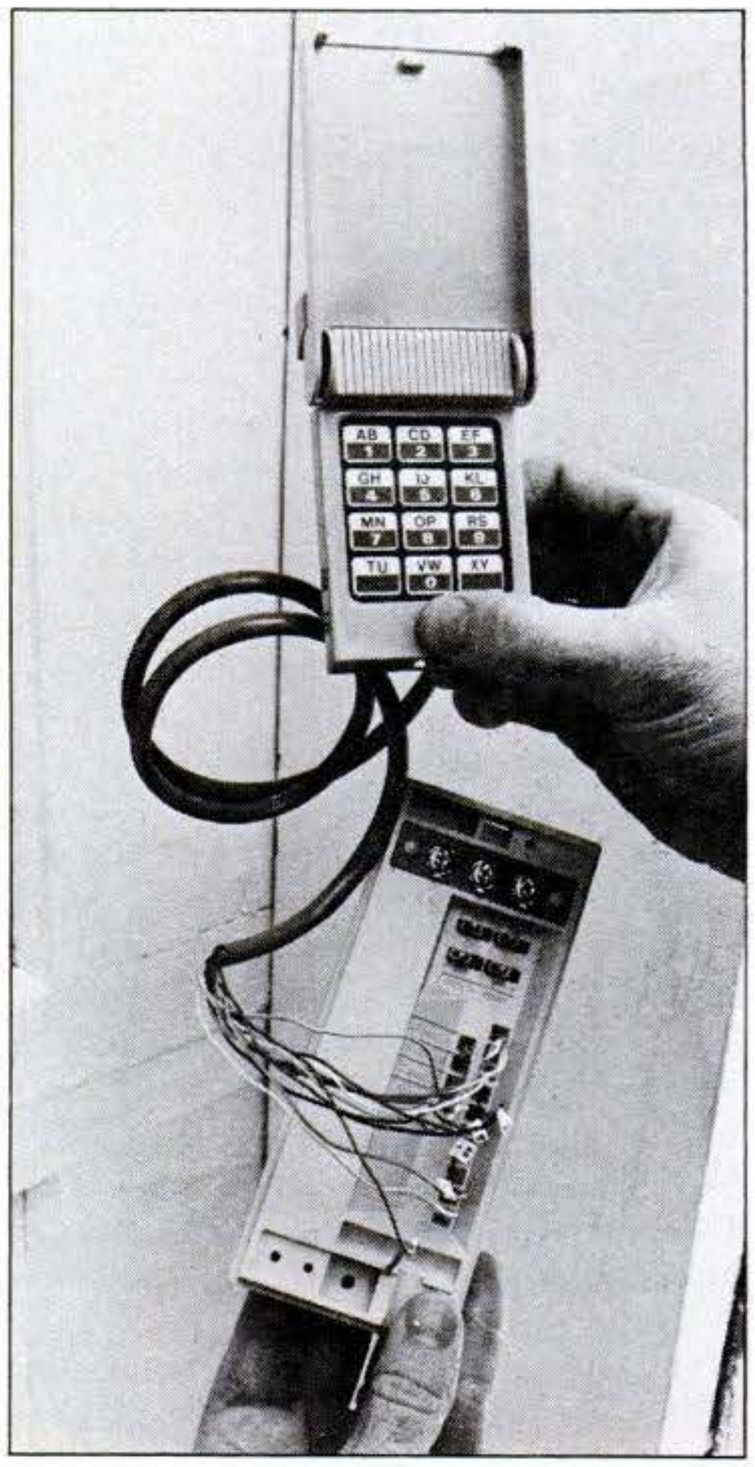
Touch the right buttons—and in the right order—and this new security system tells your automatic garage door to open up. But hit a wrong key, and a potential thief is on the outside looking in.

The Touch Code Lock from Sears takes the place of conventional key locks used on automatic garage doors. It's more convenient since all you do is remember the combination—and anyone in the family can use it. It's also safer because it's programmable—you can change the combination at any time. (You can give the combination to the mailman for a special delivery, for example, then change the combination the next day.)

The $50 lock comes in two parts: the flip-top key pad mounts on the outside of the door; the lower control box goes inside. The order in which you attach the connecting wires determines the specific four-number code to be used out of the 20,000 possibilities. The Touch Code Lock will work with any automatic garage door system.—*W. J. Hawkins*



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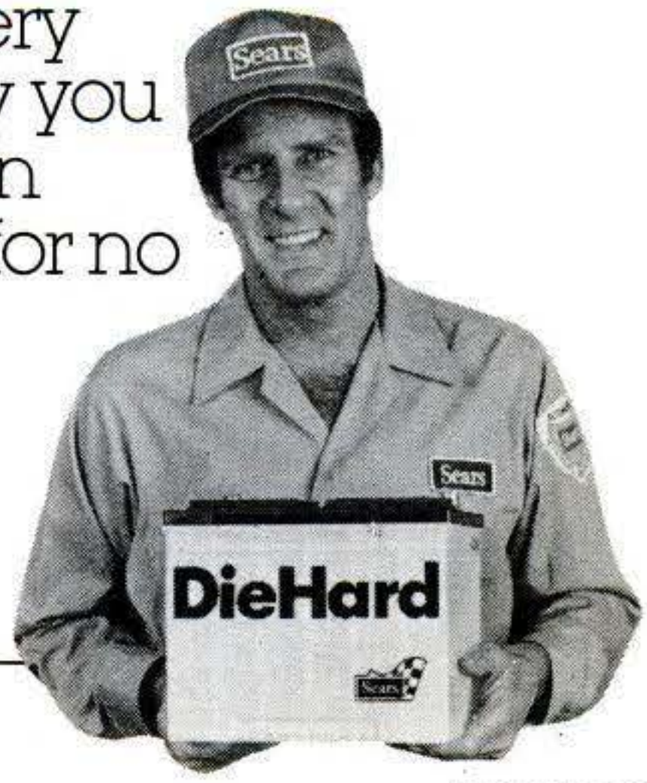

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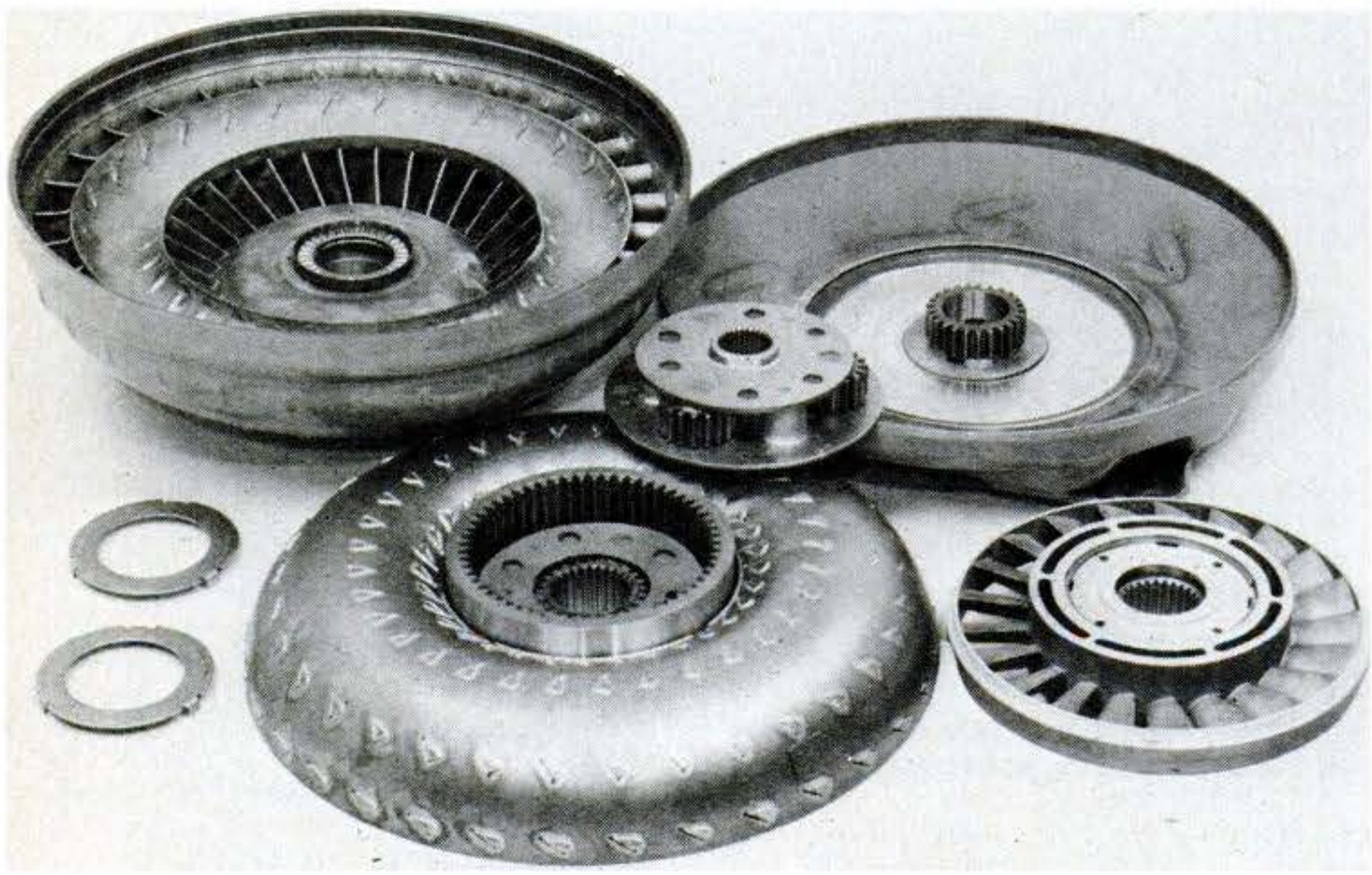
Add-on overdrive saves gas



SuperDrive looks like an ordinary torque converter from the outside. But the photo above reveals some of the extra components needed for the overdrive effect.

Designed specifically for automatic transmissions, it can even be a DIY project

By ED JACOBS

Overdrives have been known for decades to be capable of boosting fuel economy, but until recently their importance has been largely overlooked. Add-on units have been around for years, but tended to be expensive and frequently required elaborate modifications.

Now a new add-on overdrive, developed by a California company for use with automatic transmissions, may help some car owners enjoy better mileage.

In 1971, B&M Automotive Products of Chatsworth, Calif., began working on the new overdrive. B&M's first efforts went into fitting the overdrive to the transmission's tail shaft, but it was soon obvious that the installed cost would be prohibitive. Then the company looked into combining the overdrive with the torque converter, which provides the fluid coupling between the engine and transmission. The first prototype used a single planetary gear set to achieve the overdrive function, but produced excessive heat and proved too costly.

The final approach, now called SuperDrive, uses two planetary gear sets: One gives the desired overdrive ratio and the other provides a split torque path for engine power. Most of the torque flows through the converter's fluid coupling, just as all power would in a conventional automatic. The remainder passes to the transmission through a fully mechanical path, which, by eliminating some of the converter's normal slippage, means better fuel economy.

The real economy improvement of any overdrive comes from turning the drive wheels at a higher rate than the transmission normally would. Thus the engine turns slower at a given vehicle speed and burns less fuel. SuperDrive's net step-up is 25 percent.

But there is a trade-off: Vehicles with overdrives accelerate slower. While SuperDrive is no exception, a design quirk is claimed to lessen the effect. The B&M unit has a higher, 2.5:1 torque-multiplication factor, which means better acceleration from rest, though not as good overall as without an overdrive. Another drawback, according to SuperDrive Product Manager Bob Ritzman, is a bit more noise during low-speed acceleration. "But it's nothing you'd have to cover up by turning on the radio," he claims.

Perhaps one of the most attractive points about SuperDrive is that it can be a do-it-yourself project since it's designed to be a direct-replacement item. In simplest terms, that means you remove the transmission, unbolt the torque converter, and replace it with a SuperDrive, then reinstall the transmission. This takes work, but is straightforward. If you're not that much of a DIY-er, the job should be reasonably inexpensive at a shop.

That's the good news. The bad news is that SuperDrive is available only for certain automatic transmissions; that its *claimed* economy improvement can vary greatly depending on the application; and that its payback

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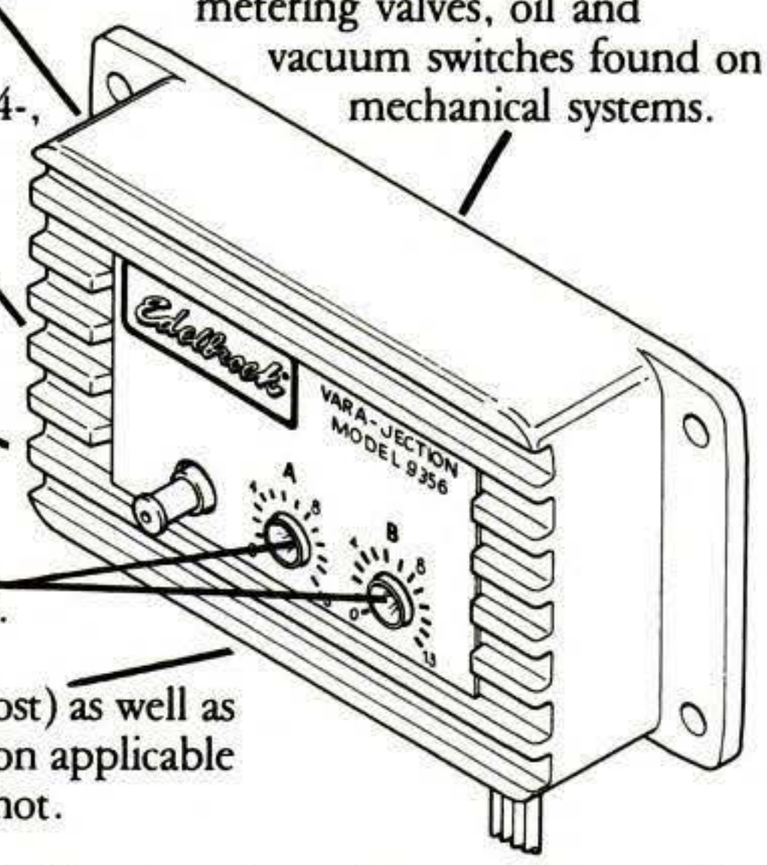
Components sense positive pressure (boost) as well as depression (vacuum), making Vara-Jection applicable to turbochargers; mechanical units are not.



Reliable, solid state electronics allows essential functions impossible to achieve with any mechanical water injection system. As vehicle and application vary, so do the amount and timing of water required to control detonation. Vara-Jection assures broad adjustment capability through a combination of fine tuning and nozzle selection. Synchronize water delivery to match your specific engine's needs through the accuracy of Vara-Jection electronics.

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Add-on overdrive

[*Continued*]

period may be too long to make economic sense.

In addition, Bob Ritzman is quick to point out that "some vehicles just aren't suited to overdrive: diesels, for instance." In fact, B&M packaging cautions against using the unit with a diesel or in a vehicle that is heavy and underpowered to begin with. To do so could produce a slow vehicle with negligible economy improvement.

At first, SuperDrive units were available only for General Motors products with Turbo Hydra-Matic 350 or 400 transmissions. But shortly a variant will be released for Cadillacs with engines of 368 cu. in. or greater. About mid-1982, there will be one for 1967–'81 Chrysler Torqueflite transmissions. And next year there will be one for Ford C6 automatics. Those applications, by the way, include cars, vans, pickups, and RV's.

B&M claims that the ideal vehicle for a SuperDrive would be one with a really large engine and a final-drive ratio of over 3.0:1. As engine size and the first digit of the final-drive ratio decrease, says B&M, so does the economy improvement.

The greatest increase in fuel economy is claimed for highway driving, where the overdrive can have maximum effect. Around town, B&M says there is some improvement but not as much as on the highway. That's because the overdrive ratio varies from zero to 25 percent as the engine and transmission cycle through speed and gear ranges.

How much of an economy improvement is there? B&M's in-house-test literature says SuperDrive produced a 15 to 20 percent gain on some vehicles. Bob Ritzman quotes 10 to 15 percent as the actual installation mix.

B&M's literature cites payback in six months if you drive a great deal, and within a year for most other applications. Those claims seem to be optimistic, however.

Assuming an installed price of $700 (cost of the unit: about $600), $1.50-per-gallon gasoline, and a base fuel economy of 20 mpg, it would take 8.5 years for a family driving 12,000 miles per year to reach payback with a 10 percent economy increase. At 20 percent, it would take 4.7 years.

However, a businessman who travels about 50,000 miles a year could reach payback in 2.1 years with a 10 percent economy boost. Twenty percent would cut that to 1.1 years. That could make SuperDrive a worthwhile investment. PS

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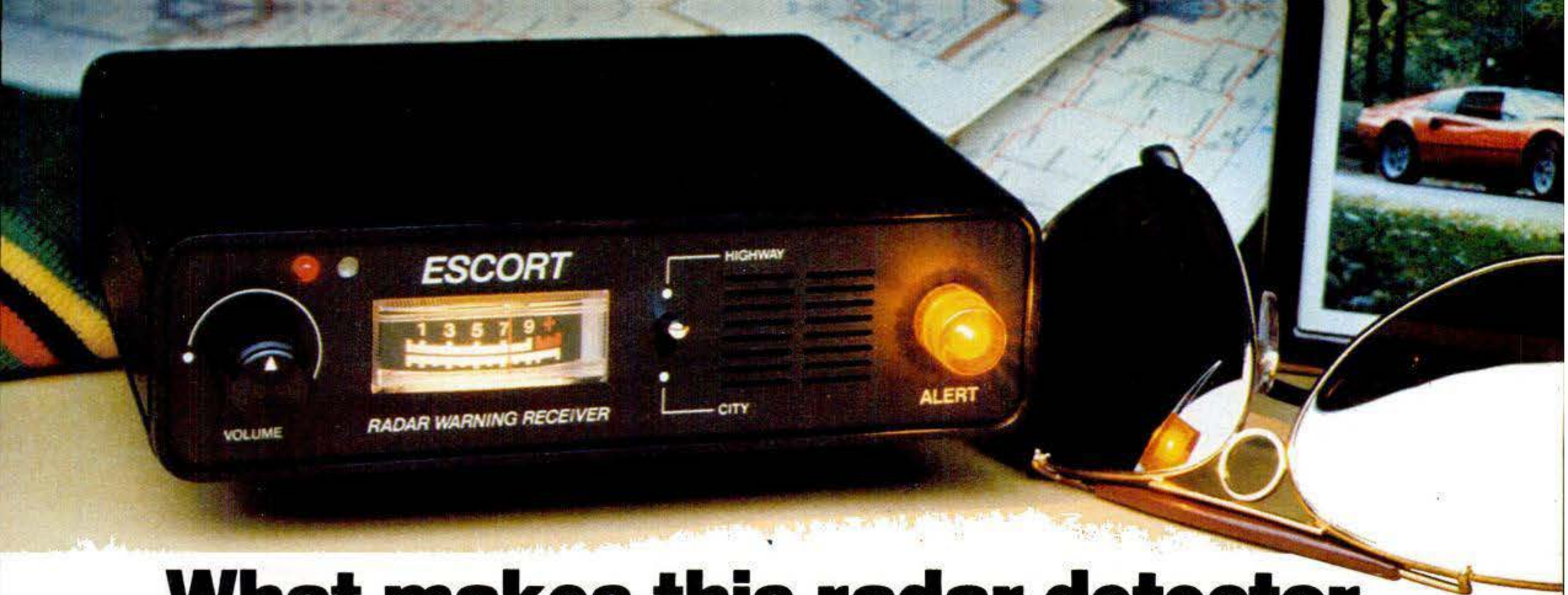

What makes this radar detector so desirable that people used to willingly wait months for it?

Anyone who has used a conventional passive radar detector knows that they don't work over hills, around corners, or from behind. The ESCORT® radar warning receiver does. Its uncanny sensitivity enables it to pick up radar traps 3 to 5 times farther than common detectors. It detects the thinly scattered residue of a radar beam like the glow of headlights on a dark, foggy road. You don't need to be in the direct beam. Conventional detectors do. Plus, ESCORT's extraordinary range doesn't come at the expense of more false alarms. In fact, ESCORT has fewer types and sources of false alarms than do the lower technology units. Here's how we do it.

The unfair advantage

ESCORT's secret weapon is its superheterodyne receiving circuitry. The technique was discovered by Signal Corps Capt. Edwin H. Armstrong in the military's quest for more sensitive receiving equipment. ESCORT's Varactor-Tuned Gunn Oscillator singles out X and K band (10.525 and 24.150Hz) radar frequencies for close, careful, and timely examination. Only ESCORT uses this costly, exacting component. But now the dilemma.

The Lady or The Tiger

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The right stuff

ESCORT looks and feels right. Its inconspicious size (1.5Hx5.25Wx5D), cigar lighter power connector and hook and loop or visor clip mounting make installation easy, flexible, and attractive. The aural alarm is volume adjustable and the alert lamp is photoelectrically dimmed after dark to preserve your night vision. And, a unique city/highway switch adjusts X band sensitivity for fewer distractions from radar burglar alarms that share the police frequency while leaving K band at full strength.

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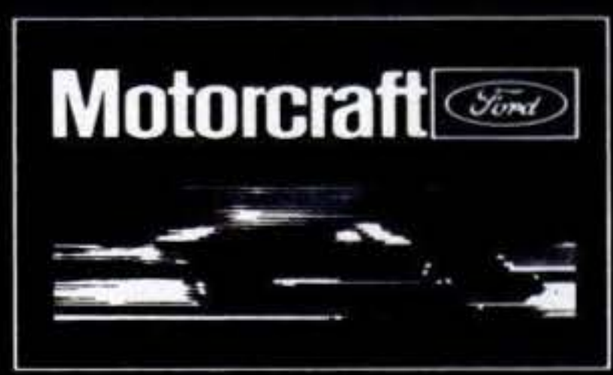

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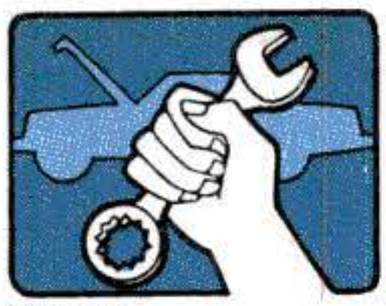

AUTO MAINTENANCE

Tougher standards for kid car seats

Improved speed tests mean safer restraints—even if parents misuse them

By WILLIAM J. HAWKINS

There's no question: Strap a child into a car seat, and he stands a much better chance of survival in an accident. Even better: Strap him into a seat that complies with the latest federal regulations.

Auto-related injuries are still the number-one killer of children in America. That's the reason for the government's continuing interest in restraining devices for children and the increasingly tough regulations.

The new standard is called FMVSS 213-80, and all restraining systems—car seats for children—manufactured after January 1, 1981, must follow its guidelines. Basically, the regulation states:

- All devices intended to restrain children in cars must be dynamically tested in a 30-mph simulated crash. A limit has been placed on the movement of the dummy, and the seat must maintain structural integrity.
- All seats requiring an additional tether strap to pass the 30-mph test must also pass a 20-mph simulated-crash test—without the tether. Seats that use an armrest or any other object in front of the child must also pass a 20-mph test with just the armrest in place.
- All buckles require a 12-pound force to open them.
- Instructions must be permanently attached to the seat and be easily visible.

As in the past, the manufacturers conduct the tests and submit the results to the Department of Transportation for approval. But for the first time, the DOT has muscle—it can enforce the regulations. "We randomly buy and check seats," explains Day Waterman of the DOT. "If they don't pass, they are recalled."

While the standard deals with the seat's structural design for better protection, it also helps close past loopholes in the law. And much of it is devoted to helping parents—who are guilty of misusing these seats. But don't get defensive. We have an excuse: If you've ever tried to figure out all those buckles, belts, straps, and plastic parts, then you know what I mean.

What they mean

The regulations cover all child-safety devices intended for use in a car. And that includes car beds. "For the first time," says David Shinn, Director of Public Education for the American Academy of Pediatrics, "the standard addresses itself to infants." In the past, car beds or infant carriers were not covered by any regulations. Now that they are, "they're essentially outlawed," he adds. "They won't pass the tests."

Although makers can't *say* the bed is made for a car without coming under the standard, they can *imply* it is by calling it a travel or carry bed. Don't be fooled. These beds may be fine for some uses, but don't expect them to protect your infant in a car.

Booster seats for larger children are relatively new and are also now covered by the standard. The seats are basically the same as a booster chair used at home, except they have shoulder harnesses and work with the seat belt. They raise the child up so he can see out the window. That's a big plus if you've ever tried to get your kid into a car seat. They also position the lap belt better for a smaller pelvis.

Because of their simplicity, the boosters are becoming very popular. But, also because of that simplicity, they are difficult to design and still meet regulations. At present only one maker, Century, has an approved seat available.

Oddly, the tests now required are likely to have little impact on most other seat designs—infant carriers, toddler seats, and convertible models. (The latter are built in sections so they can be rebuilt to fit your children as they grow.) The tests include an already existing static test—pulling on the seat and harnesses to check their strength—and new dynamic tests on a sled. The seat and dummy are accelerated up to speed and stopped suddenly to simulate a crash. "Eighty percent of the manufacturers' products already meet the new specs," says DOT's Waterman.

What's significant, however, are the two speed tests now required. The first, at 30 mph, is with all the seat's protective straps in place. This test assumes the seat is being used properly. The second, at 20 mph, assumes that the seat is installed incorrectly.

"The main motivation behind the new specs is to compensate for misuse of the seats," says Shinn. "Some seats require a tether strap to be anchored to the rear-window shelf or cargo area of the car, for example. Many parents simply don't use it."

While this second test builds in some measure of safety, it is no replacement for installing the seat correctly. If you are using an infant seat that converts to a child seat,

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For more information, you can write to the Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C. 20590; to the American Academy of Pediatrics, Box 1034, Evanston, Ill. 60204; or check with your own state government (often under the Department of Public Safety). Some states (eight so far) now have laws requiring the use of child-restraining systems.

For information on specific products, write to the manufacturers. A sample listing is: Bobby-Mac (photo at left), 95 Morris La., Scarsdale, N.Y. 10583; Century, 1366 Commerce Dr., Stow, Ohio 44224; Cosco/Peterson, 2525 State St., Columbus, Ohio 47201; Ford, 3000 Schaefer Rd., Box 1902, Dearborn, Mich. 48121; Questor, 1801 Commerce Dr., Piqua, Ohio 45356; Strolee, Box 5786, Rancho Dominguez, Calif. 90224.

check to see if it requires the tether strap. Naturally, if it does, use it.

One of the most obvious changes is on seats that use a front armrest. On these, the armrest swings down over the child and straps are used to hold him in place. The problem was that many parents considered the armrest itself to be the safety device—disregarding the additional belts. That made the seat extremely easy to use, and, ironically, extremely popular.

But the cure is also extremely simple: a spring. On new seats, the spring pulls the armrest up if it's not held down with the properly buckled straps.

The ultimate goal seems simple: Keep your kid in the car seat. But if your children are like mine, that means wrestling with one hand, grappling at straps with the other. And the result—buckled-in kids—lasts just as long as it takes them to push the button on the buckle. (This usually occurs as I enter traffic.)

For that reason, I particularly appreciate the minimum-12-pound buckle force now required to open the straps. (Manufacturers are using 14 to 16 pounds.) It means that once the fight is over, my kids are in for the duration. They're simply not strong enough to open the buckle, but adults are. (Makes you wish they had a model for the bed at night.)

And as one who owns those convertible seats, I also appreciate the regulation forcing makers to provide a place on the seat for the instructions—so you won't lose them as I did.

All sounds great? Sure, but be careful when you shop. The standards only cover seats made after January 1981. They don't cover older seats still on store shelves. Each seat contains a label showing its date of manufacture, however; be sure it's dated after January '81.

"There's still junk out there," Waterman told me. "Be suspicious of anything that costs less than $20. The new standards make the seats more expensive, but they'll last longer and can be used as hand-me-downs. And what's best of all, they'll be safer to use." PS

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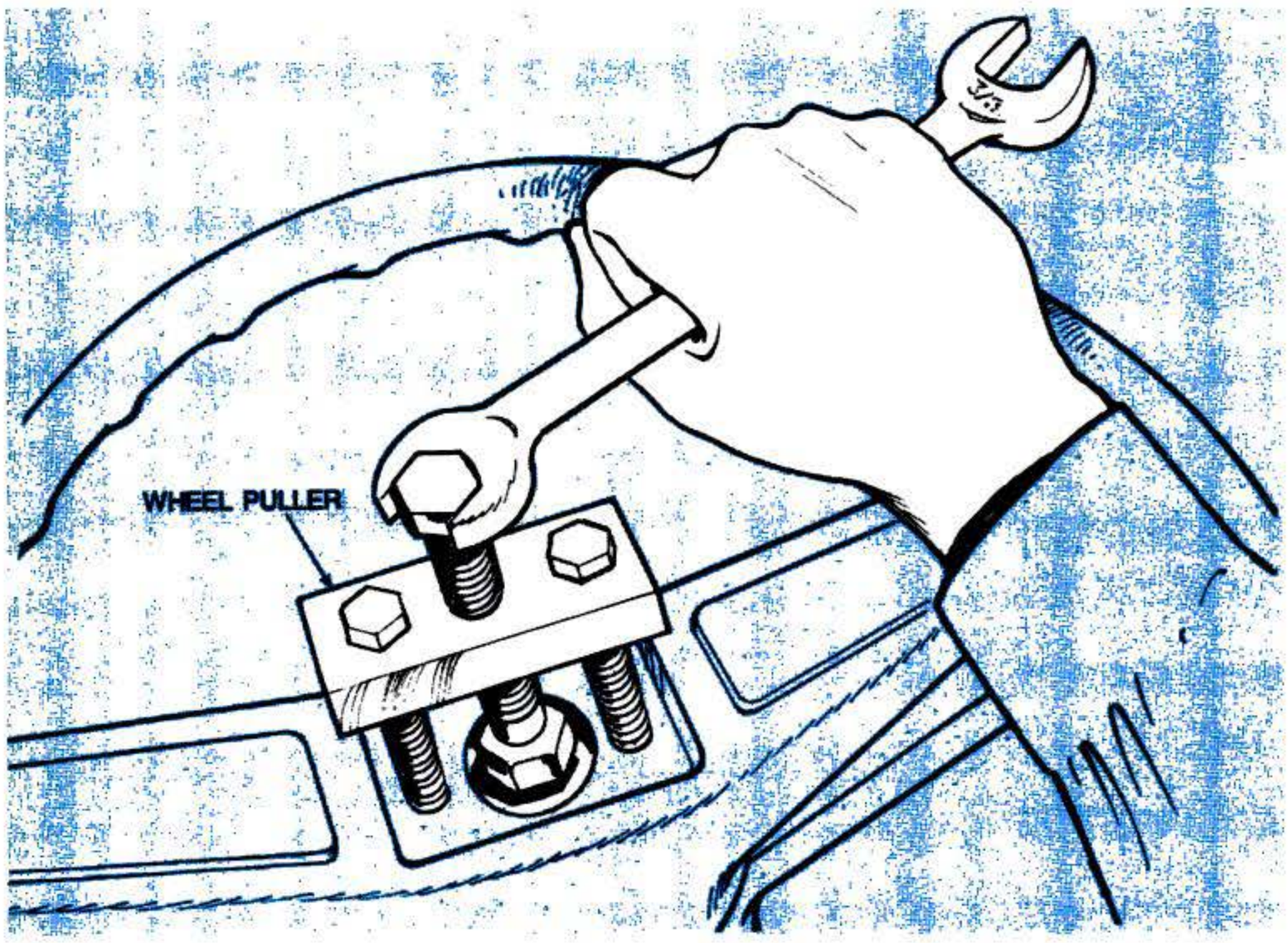
TAKING CARE OF YOUR CAR

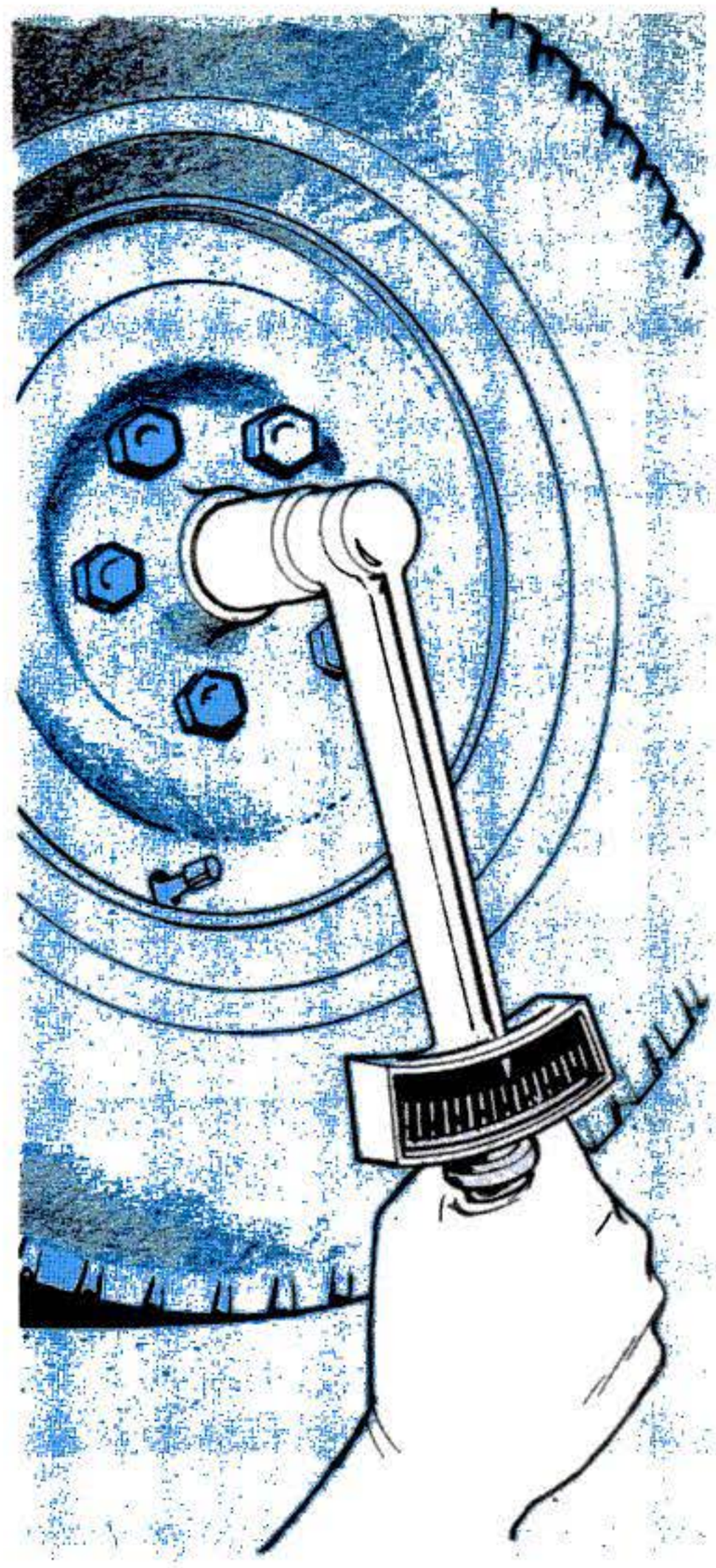
By RAY HILL

Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay $50 for each tip used. In case of duplication, earliest postmark wins. Tips can't be returned.



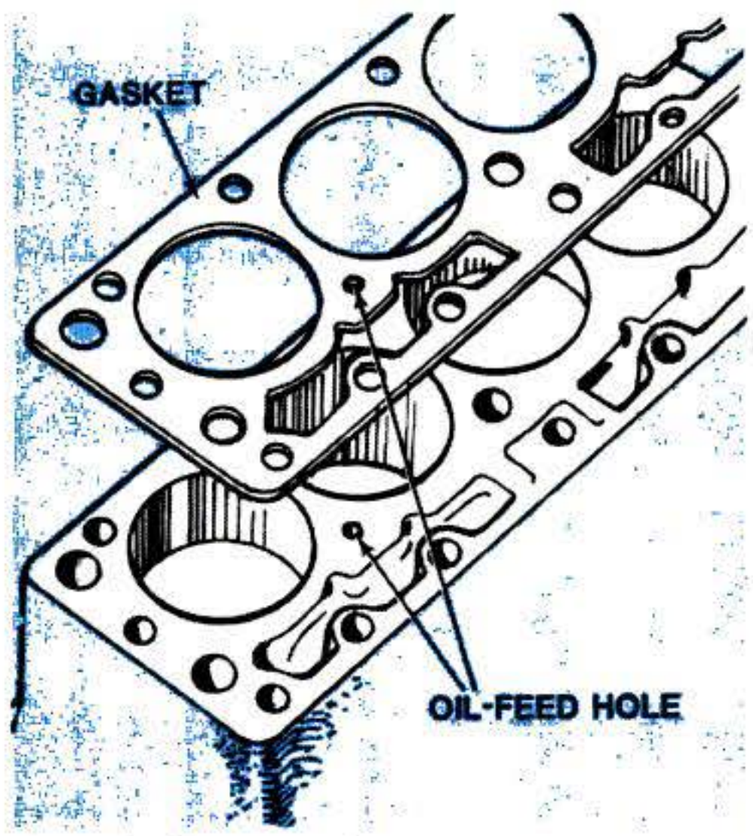
Removing a steering wheel without damaging any threads

The only correct way to remove a steering wheel is with a steering-wheel puller. But first, loosen the steering-wheel nut and unscrew it until it's flush with the top of the steering shaft. This will keep the metal at the top of the threads from mushrooming out and damaging the threads. After the steering wheel is broken loose by the puller, remove the nut and lift the wheel off. Most steering wheels have a scribe mark that corresponds to a mark on the steering shaft. (If yours doesn't, mark wheel and shaft yourself.) Be sure the marks line up when you replace the wheel.



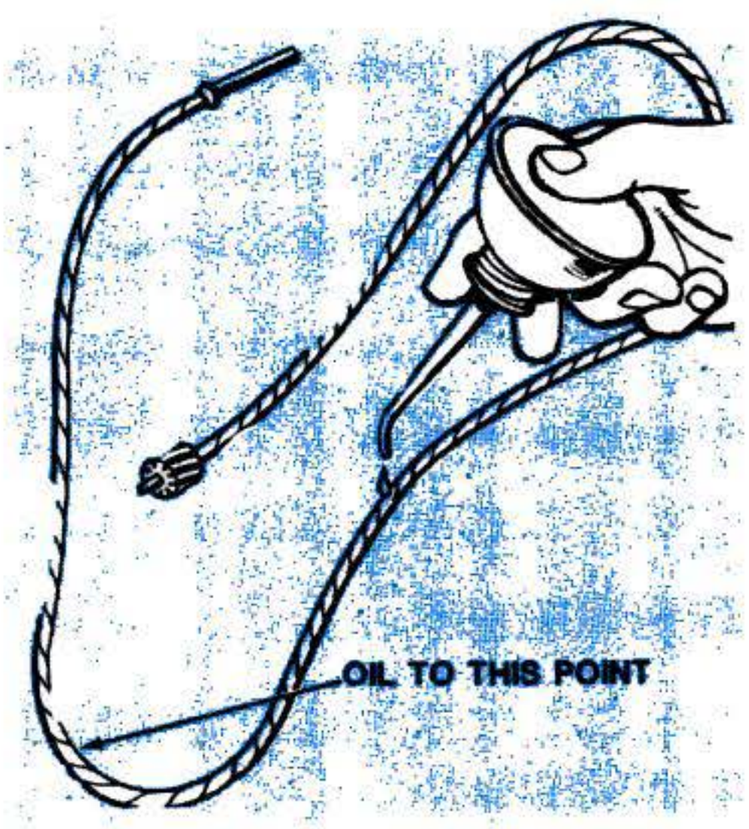
Low brake pedal

On cars with disc brakes, loose wheel bearings can cause a low brake pedal. They let the rotor wobble, which pushes the piston farther back in its bore than it should be. Check and adjust wheel-bearing clearance according to the specs and procedures in your service manual.



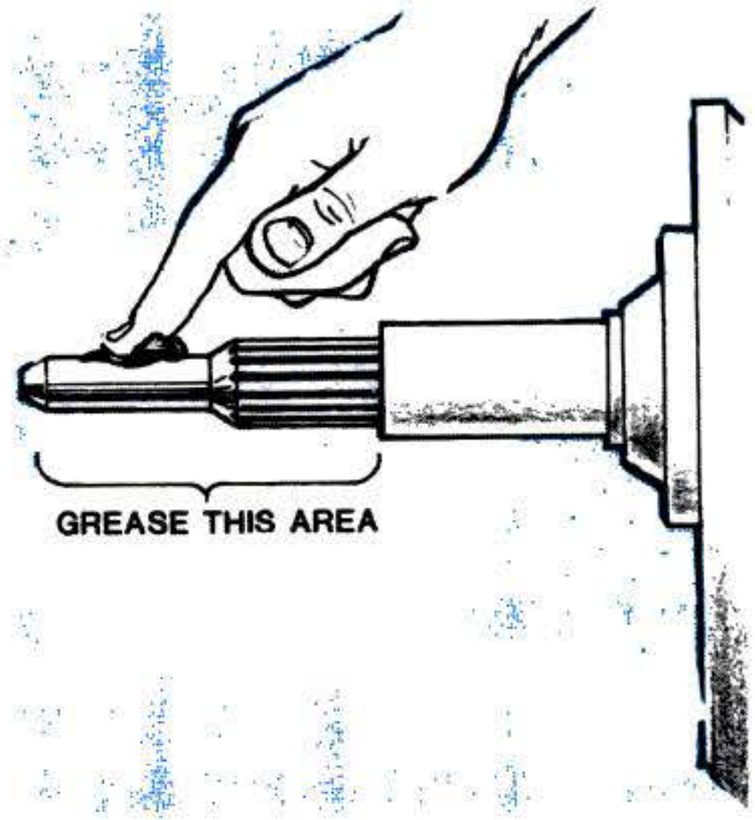
Don't flop gaskets

When installing a gasket, be sure that the gasket isn't put in backward. It should align perfectly. If it's reversed, vital passages may be blocked. With a head gasket, for example, if an oil-feed passage to the rocker-arm assembly is blocked, destruction of the valve train can result.



Speedometer needle jerks

A jerky speedometer needle may be caused by a lack of lubrication. Remove the cable and coat the lower two-thirds of it with a lightweight oil. Don't coat the upper third—the oil might work itself out into the passenger area, soiling clothes and making a mess.



Replacing a transmission

When installing a standard transmission, put a light film of grease on the input shaft. If you don't, shifting gears may result in noise, failure of the clutch to release completely, difficulty in depressing the clutch pedal, or failure of the clutch to engage completely.

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"SAY, SMOKEY—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

Steady speed impossible

I have a 1969 Toyota Corona with a 1,900-cc RC3 engine. I bought it used in December 1975. When I try to hold the accelerator pedal steady at any cruising speed, the engine speeds up and slows down at a rate of about twice a second. During acceleration or deceleration, however mild, the engine runs great. When it changes speed, the engine drives the car, then the car drives the engine, and a furious clanging through the gears occurs. I have changed the distributor, points, spark plugs, plug leads, condenser, carburetor, and had the inlet-manifold face machined to ensure there was no air leaking in.

Is there something you can recommend before I buy another engine?

Lionel H. Brooks, Leucadia, Calif.

Unwanted speed change is largely caused by air being supplied to the engine without control. Leaking, loose throttle plates, a vacuum leak, motor mounts letting the engine shift, or a dramatic timing change of five or more degrees (caused by a vacuum-advance or mechanical-advance malfunction) are the more likely causes.

Of course, it could be some weird deal such as a plugged exhaust or carboned-up intake ports—which would limit engine breathing.

Not up to snuff

I had a '62 Chevy two-door with a 327-c.i.d. four-barrel carb and twin pipes—as hot as they came. I drove it (from new) for over 100,000 miles with no problems. Now—though I'm a fair mechanic—I've got a puzzler: My present car is a four-door '69 Chevy Impala with exactly the same engine as the '62, except with a two-barrel carb and single exhaust. I bought it new, and it's in tip-top shape. I keep it tuned to a fault—the best I know, anyway, without a shop-type analyzer (Sun, etc.). What puzzles me is that my '62, no matter how I pushed it, got 17–20 mpg. The '69 does well to get 15.

I know the '69 weighs a lot more. And the grade of gas doesn't help either. In fact, 88-octane regular works even better than high-test. The '69 has just short of 200,000 miles and I really can't complain, but do you think a four-barrel carb with twin pipes will help enough to at least partly offset the cost of doing it?

Incidentally, both cars have the Power-Glide transmission, and the '69 doesn't seem to be slipping (a professional told me it was "perfect—leave it alone"). It's never been touched.

Harry DeVasher, Temple City, Calif.

A four-barrel carb and manifold could help a little. Weight and gear ratio are big factors. You can't help weight. But you can up axle ratio to cut rpm down. Go with as much timing as it will stand, and run it hot.

Backfiring during deceleration

After about 24,000 miles my 1978 Horizon began to backfire during deceleration, but only when the engine was cold. The dealer rebuilt the carb, then replaced it with a new one. Plugs and rotor were replaced. The problem remains. (A month or so prior to this problem, the voltage regulator and alternator had to be replaced.) Do I have a fuel problem or an electrical one?

Harvey W. Noordsy, Syracuse, N.Y.

Take your AIR-pump belt off and see if you've still got backfire during deceleration. If not, the AIR system is malfunctioning [PS, Dec. '81]. It's supposed to divert the air from the exhaust system during deceleration. If it doesn't—and this may be your problem here—backfiring can occur, because there's more unburned fuel in the exhaust. It's the diverter valve's job to dump the air from the AIR pump to the atmosphere. Either the diverter valve is bad or it's not getting its vacuum signal during deceleration.

Slipping clutch

I own a 1975 Buick Skyhawk with a 231 V6 engine. Just recently I have noticed a huge loss of power. The car has a four-speed transmission, and every time I put it in first gear and start to pull away, the rpm will rev up to as much as 4,000, but I'm only going 10 mph. What can I do to get back the pep of my once very peppy V6?

Bill Boehm, Naperville, Ill.

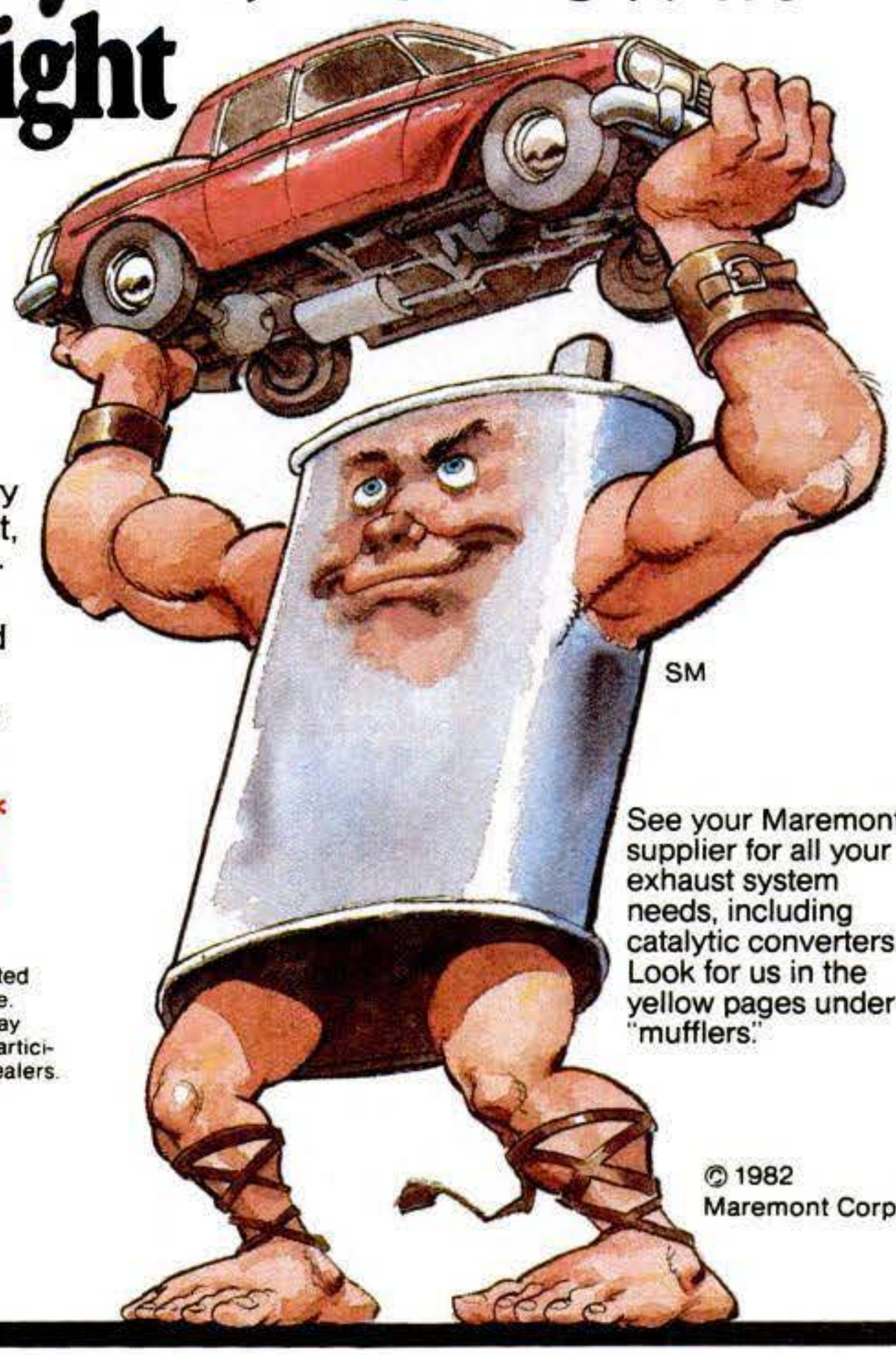
By now, I'm sure you've bought a clutch.

Should he burn propane?

I saw an ad on TV about an RV that was equipped with a propane and gasoline converter that can be changed by pulling a button on the dash.

I have a '79 Chevrolet van with a 350-cu.-in. V8. I would like to know about this system. The man on TV said that you could get 62 mpg on propane. My van is a work van. I wondered if it would be prac-

Heavy-duty muffler now at a lightweight price!



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tical and economical to have the change made.

My van has about 1,900 miles on it.

Wendell L. Baker, Orlando, Fla.

Propane is a good fuel in very short supply. It gives 10 percent less mileage per gallon, and it won't hurt your engine. Forget changing over. It will shortly cost more than gasoline. As a matter of fact, it already does if you look at the bottom line.

It burns quite cleanly and is very good emissions-wise. I wish it were possible to use it.

Mysterious missing

I have a 1974 Volvo 145, standard transmission, 68,000 miles, new plugs and points. After I accelerate hard in third or fourth gear, the engine starts missing badly. After a few miles, the miss mysteriously disappears. I have tried a two-hour cool-down while it was missing, but the miss continued upon recranking, then disappeared two miles later. Could it be in the fuel-injection system?

Gene Lueg, Ruston, La.

Missing on acceleration as a rule is ignition trouble. But a lean fuel-air mixture can also cause it, and is more likely to show up with fuel injection than with a carb.

Sometimes a miss like this can come from a dirty or wet spark plug that clears up after it gets hot. Or from an air leak on the inlet side that quits when the heat causes things to tighten up.

Broken distributor shaft

What would cause the distributor shaft to break at the gear on my 1978 Chevrolet Caprice Classic 305? The car has 23,000 miles on it.

To make matters worse, the gas station could not buy just a shaft, so I had to pay $219, plus labor, for a new distributor. Nothing else was wrong with the engine.

Thomas Stylski, Redford, Mich.

The distributor drive shaft drives both the oil pump and distributor. Turning the distributor guts is very easy, but the oil pump is tough. I hope you haven't broken another shaft by now. Look for a problem with the oil pump.

If the distributor bearings, upper or lower, had a lube problem and seized, that could also break a shaft.

Lowering compression

My 1969 Chevy Corvette 350-hp, 350-cu.-in. engine has an 11:1 compression ratio. I'm having trouble with spark knock due to the premium-gas octane rating getting lower, and also hard to get. I'm due for a motor overhaul. Should I put in flat pistons?

Is there an additive that I can economically use?

George Shipman, Houston, Tex.

I know it's not going to be an answer you'll like, but as long as you're ready for an engine overhaul, drop her back to 8:1 or no more than 8.3:1 compression ratio. Octane additives are a long story that gets you nowhere. Your Chevy dealer has pistons for you. Yup, they are flat.

Dropped a valve

My 1973 Toyota pickup had a valve job done by an excellent mechanic and part-time racing-engine builder. About 550 miles later, the exhaust valve in the number-four cylinder got overly intimate with the number-four piston. The valve was bent and the piston crown was dinged. This happened at 50 mph in fourth gear, on regular (leaded) gas. The valves were unadjusted since the valve job, and were within adjustment specifications after the fun. What happened?

Donald C. Koury, Post Mills, Vt.

I'd say it was either a sticking valve, a weak or broken valve spring, or the engine was overrevved. You didn't mention springs, so I'd guess either sticky valves or overrevving.

Engine overheats

I have a 1971 Dodge Dart (six-cylinder, 225 c.i.d.) with 63,000 miles. When the air conditioning is on, the engine overheats. The air-conditioner compressor is two years old. We have replaced the radiator cap, thermostat, and radiator hoses. The radiator has been power-flushed and 50-50 antifreeze added. Anti-leak and anti-rust are added each year. We like the car. What else is there to do?

Leon Reinstein, Baltimore, Md.

Remove the thermostat housing and water-pump belt when the engine is cold. Fill with water to the top of the thermostat housing. Start the engine and accelerate it by hand, observing water for movement or bubbles. If you find either, look for gasket trouble; if not, pull the radiator and have the core cleaned out or replace the radiator. Examine the air-conditioning condenser for an air-flow restriction.

Ballast resistor unreliable

I own a 1979 Plymouth Volare station wagon. I have replaced the ballast resistor three times because of failure (cracking, warping, etc.). How can I correct this?

Robert W. Harp, Schuylkill County, Pa.

It's caused by too much heat. Heat usually comes from too much voltage, which might be caused by a wiring problem.

Each month, Smokey Yunick answers questions on cars—family cars, high-performance models, and racing vehicles. Got a problem? Send it to: "Say, Smokey—", Popular Science, 380 Madison Ave., New York, N.Y. 10017. Smokey reads all letters, answering those he feels are of widest interest. Due to the large volume of mail, Smokey cannot reply to letters that are not answered in his column.

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HOUSEPOWER CLINIC

By EVAN POWELL

Cutting hot-water costs

The "sidearm" boiler—a hot-water space-heating system that incorporates a separate heating coil for domestic hot water—is quite effective in winter when the home requires heat. But it's terribly inefficient in summer when the boiler must be kept fired just to provide hot water. If your house has such a system, perhaps you can benefit from an experiment by Richard E. Mann, manager of commercial engineering for GTE lighting products. He has cut his summer water-heating costs in half by using a manual 60-minute timer connected in parallel to the oil burner's main power switch and developing a routine of water use.

The first step is to adjust the aquastat, which controls water temperature, to a high of 160 degrees F and a low of 140 degrees. The typical 200-degree temperature may be required for heating the house in winter, but it is unsafe for hot water and costly in summer. After you've reduced the temperature, turn the main boiler switch off and turn on the burner with the manual timer a few minutes before you want hot water. By careful planning, Mann gets by with firing up his burner only twice daily—for a total running time of 22 minutes.

In his system, Mann found that a bath requires 15 minutes of burner running time; a shower, seven minutes; and the clothes washer, zero—it cleans effectively with cold water. I recommend five to eight minutes before running the dishwasher.

Sixty-minute line-voltage timers are available from any electrical-supply store for about $20. Mann calculates that his fuel-oil costs for water heating were reduced from $39 a month to $19 and that he saved $100 in one season.

Multi-housing applications

As multiple-dwelling homes become more common, more readers are requesting home-equipment information geared to those special needs. Actually, this is built into most of the reports we do. But you may need to apply the information differently. Water-saving devices, which we covered in August 1977 and will update soon, are a good example. David Wilborn of Metropolitan Water Saving, manufacturer of the Little John toilet dam and water-saving shower heads, tells me of apartment and condominium projects where these devices have been installed by the grocery-cart-full, and savings have been of the same magnitude.

In a condo, you can usually initiate such modifications on your own, but check your contract first. In a rental apartment, you can do yourself and the owners a big favor by selling the apartment manager on an energy-saving project.

Q&A Sensing trouble

I was having trouble with my Maytag dryer with automatic sensor. I had been using either a stick-on fabric softener or the sheets you tear off and throw in. My service technician said that both kinds can cause a film to form over the sensors that keeps them from working properly. That might be worth checking before investing in a new thermostat or timer.

Esther Schmiedere, Dennisport, Mass.

Dryers that use drum-mounted sensors, or "fingers," in conjunction with an electronic control do indeed depend on good contact between the clothing and the metallic foil on the sensors. If the sensors become coated, moisture in the clothing will no longer conduct a tiny electrical current between them. Consequently, the dryer shuts down—prematurely.

Use care in cleaning them, however. Wiping with a damp cloth is usually all that's necessary. The owner's manuals of most dryers with these sensors give specific instructions.

Dishwasher-tub repair

My GE dishwasher, model GGSD 650N51, has developed rust spots on the inside bottom, and it leaks. The inside of the dishwasher has a plastic coating. Can you tell me what to use on these very small rust spots and how to keep more from developing?

Allen Richart [no address]

It's important to repair nicks and rust spots quickly on dish- and clothes-washer tubs. Once the tub is perforated, the only sure-fire repair is to replace it. But epoxy repair kits are worth a try.

First be sure that the leak is coming from the rust spots you see, however. Often, especially in the newer models with good protective coatings, those rust spots are only on the surface. If yours are not, you can order an epoxy kit by model number from GE. Follow the package instructions carefully, be sure that all surfaces are clean and dry, and allow 24 hours' curing time before using the machine.

Heat-pump water heater 'stat

I've installed E-Tech's Efficiency II heat-pump water heater and need a schematic wiring diagram to trouble-shoot problems. The 24-V thermostat doesn't tell the heat pump to go to work as it should.

Jack Lang, Portland, Ore.

I've notified E-Tech of your problem, and the company has arranged for a local dealer to replace the thermostat. It should be done by the time you read this. The problem is likely a common one with bimetal thermostats: The contact becomes coated with lint, dust, or glass-fiber insulation particles, which prevent conduction.

The latest versions of the Efficiency II use a sealed, gas-filled thermostat that isn't susceptible to such fouling. It is incorporated into the lower water-outlet fitting. Some older models can be retrofitted with this assembly. But you may not need this. To protect the new 'stat, you might shield it (with a cardboard frame) from the insulation around it. My original Efficiency II has been operating for almost three years with a 'stat like yours and has given no problems. The wiring diagrams are in your owner's manual—if you don't have one, E-Tech can provide it.

Question and suggestion

My GE electric range (J466Y1DC) works as it should, but I've noticed that some models with the same push-button controls have a small pilot lamp under the GE logo. It comes on whenever a top burner is on. Is it possible to modify my stove to incorporate this feature?

Also, I've noticed that many frost-free refrigerators have a fairly well-hidden tube to drain condensate into a pan during the defrost cycle. When this tube clogs with dust and algae, you know what happens. Since it is important to keep this tube clean, I think it should be mentioned in owner's manuals.

Bill Battis, Alsea, Ore.

First, the question: Turn off the power and look at the rear terminals of your range's switches. If they have an unused terminal marked P, you can use that to energize a pilot lamp. (A 7½-watt light bulb or any small 110-V lamp can be used. But you may have a problem finding a place to mount it.) Use a 14-gauge conductor from the P terminal as the line to the light, and connect the other side of the light to the neutral (middle) line at the terminal block. It's a big job, but a pilot lamp is convenient. If there is no P terminal on the switches, forget it.

Now for your suggestion: I agree that instructions for cleaning the drain tube should be included in manufacturers' manuals—some do include them. And it's a timely reminder for PS readers, since it's primarily a summertime problem. After cleaning that tube, pour a tablespoon of household ammonia through it to kill any remaining spores.

Got a home-equipment problem? Write to Evan Powell/Housepower, Chestnut Mountain, Route 1, Box 322A, Travelers Rest, S.C. 29690, giving appliance make and model number. Unpublished questions cannot be answered by mail.

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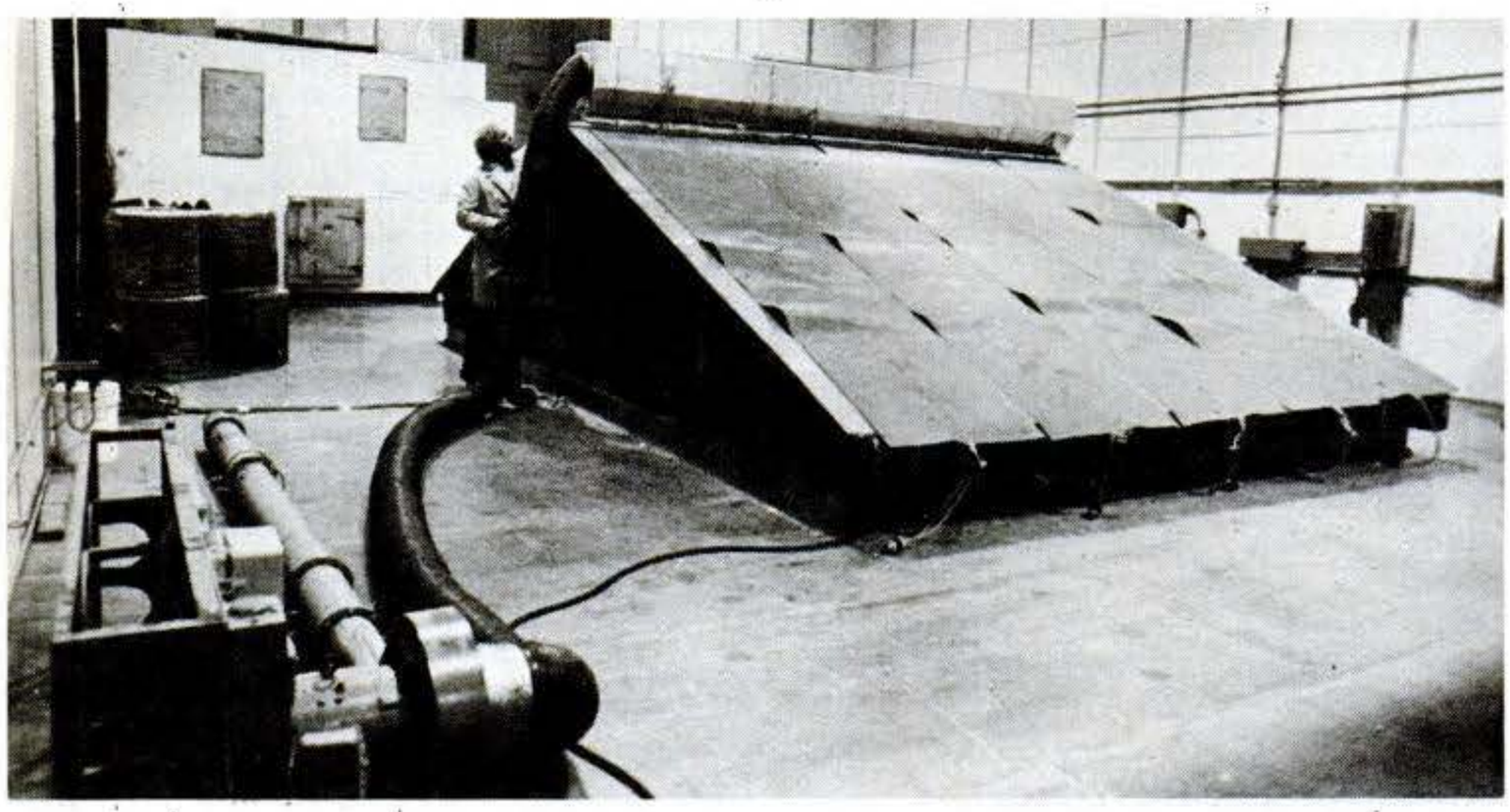
SHOP TALK

By AL LEES



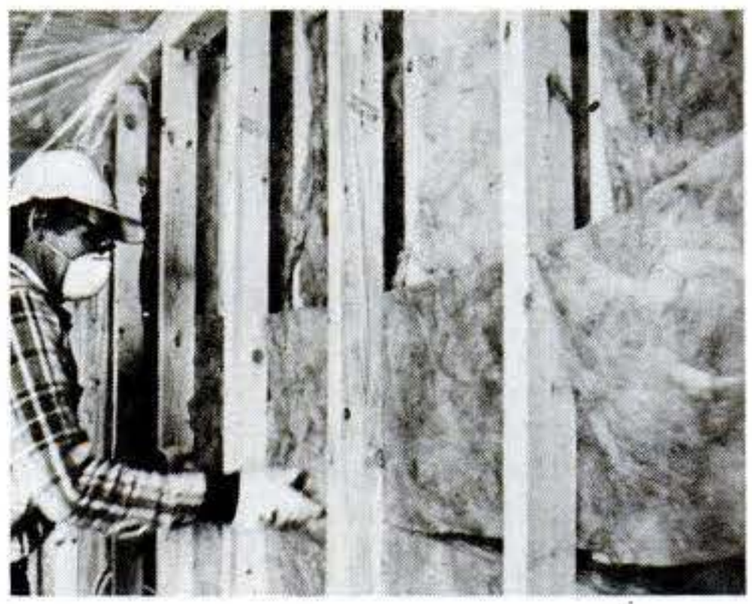
Here comes EPDS!

I'm just back from the annual convention of the National Association of Home Builders—held for one last time in Las Vegas. Perhaps the most important innovation demonstrated there was Owens-Corning Fiberglas's system for evaluating a home's energy efficiency *before* it's built. The system was especially interesting to me since it's the culmination of all the research from OCF's elaborate facilities at Granville, Ohio, on which I reported in our February '79 issue.

In that report I told of the huge labs for measuring the thermal performance of entire wall and roof assemblies (top photo), and described the long-term monitoring of three identical ranch-style homes built on a windswept corner of the lab's 500 rolling acres. The first of this trio had *no* insulation; the second was insulated to then-current standards; and the third was beefed up to the R-19–38 ratings then being promoted by the Arkansas Plan [PS, Sept. '76]. All three houses bristled with monitoring gear and were plugged into a central computer. When I saw them, they were sealed for a full year's study under identical weather conditions.

OCF's new evaluation system is the payoff for these years of data gathering. It's called EPDS—for Energy Performance Design System—and it's meant to help builders design (and buyers compare) new homes for optimum energy efficiency. EPDS is a computer program (plus a detailed workbook) that lets a builder rate the energy performance of any house plan so as to compute how it might be improved.

After witnessing several demonstrations, I can attest that EPDS is a sophisticated new tool of great potential. One house builder, in Madison, Wisc., has



already demonstrated its effectiveness by revising one of his standard plans to the computer's recommendations. One construction change was to frame all exterior walls that had exposure to cold winds with double studs to permit an extra, unbroken layer of insulation (see second photo).

Although this builder's original plan was rated as energy efficient, and the changes added only five percent to the construction costs, early monitoring of the computer-revised house promises a 50 percent reduction in fuel costs this winter.

EPDS will be available to all professional builders by summer—and it will be free. OCF is already at work to expand the program to include accurate evaluation of retrofitting plans, so you or your remodeler may be plugging into this self-updating data bank in the future.

EPDS is to homes much what mileage ratings are to new cars. Just as personal driving habits affect actual mpg, varying living habits can alter home energy consumption. But at least there's now a basis for valid comparison. If you're thinking of a new home, you'd be wise to ask your builder for its EPDS rating. And if you want to make changes on the basic plan, have him check these with EPDS: The system will quickly tell you what a picture window on the north wall will cost you in fuel dollars. You can even "move" your house to different climate zones to see how it would compare in energy costs.

Aiding the vandals?

David Spicer, a reader in Canton, N.C., writes: "I'm puzzled by the item on Tufnuts in your January column and your promise to show, in the following issue, how they're installed. Once the word spreads (thanks to PS), traffic signs will be coming down again and we taxpayers will still be paying for their replacement. It seems more appropriate that you withhold this information. Common sense is PS's stock in trade. Please exercise some."

Both PS and the manufacturer of Tufnuts have received so many complaints like this one that a response is required:

In order to promote the product, the manufacturer must (of course) show that Tufnuts work simply, without special tools. In order to introduce this product to our readers for their own use, PS must (of course) print the manufacturer's address. Anyone determined to "crack the nut" in order to go on stealing signs had only to write Tufnuts for the brochure, which details the installation procedure and gives nut-size data. Since any would-be vandal would have to order matching nuts from this source anyway, he'd automatically get this information.

I feel PS is still firmly on the side of common sense. And Tufnuts remain a good deterrent against the casual, impulsive vandalism that's the current scourge of this country.

Final word on HIY

Rich Day's report, last July, on problems he'd encountered with haul-it-yourself concrete continues to draw bursts of applause and howls of protest—the latter from HIY companies that weren't mentioned in the article. In our November issue we ran a follow-up on two other trailer systems that were actually portable batch plants. Now comes a note from the very franchiser chain that Day used as his example in the July report.

"We've received a lot of pro and con comments in the months since your July article," writes Rod Brooks, president of U-Cart Concrete Systems, Inc. (with over 600 retail outlets across the country). "I felt it was a candid appraisal of our system, both good and bad. We've now developed an improved system that measures precise portions of sand, aggregate, water, and cement. Two five-yard hoppers hold sand and aggregate, eliminating any need for pre-blended materials. A digital weight meter weighs each ingredient so high-quality, low-slump concrete can be quickly mixed for transport to the job in trailers. A concrete additive prevents settling, separation, or setting of the concrete in transit. In short, this MH-2 system eliminates the guesswork from our product."

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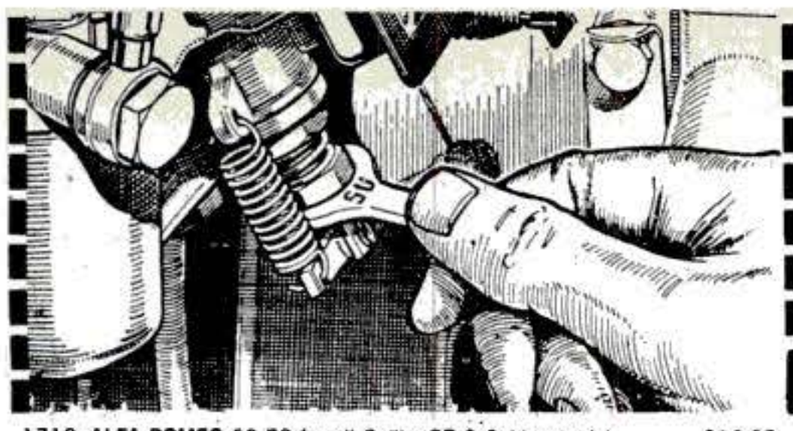

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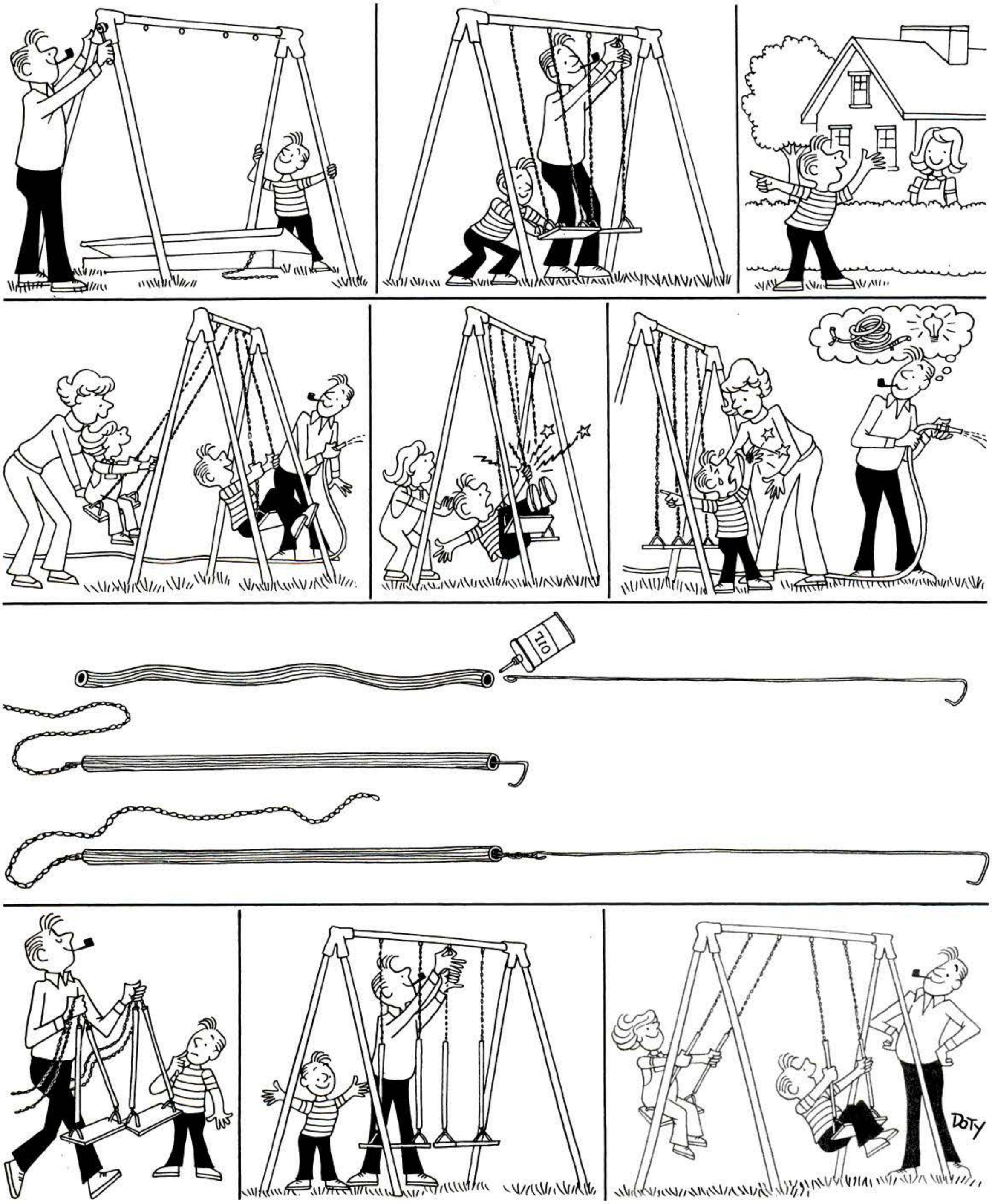

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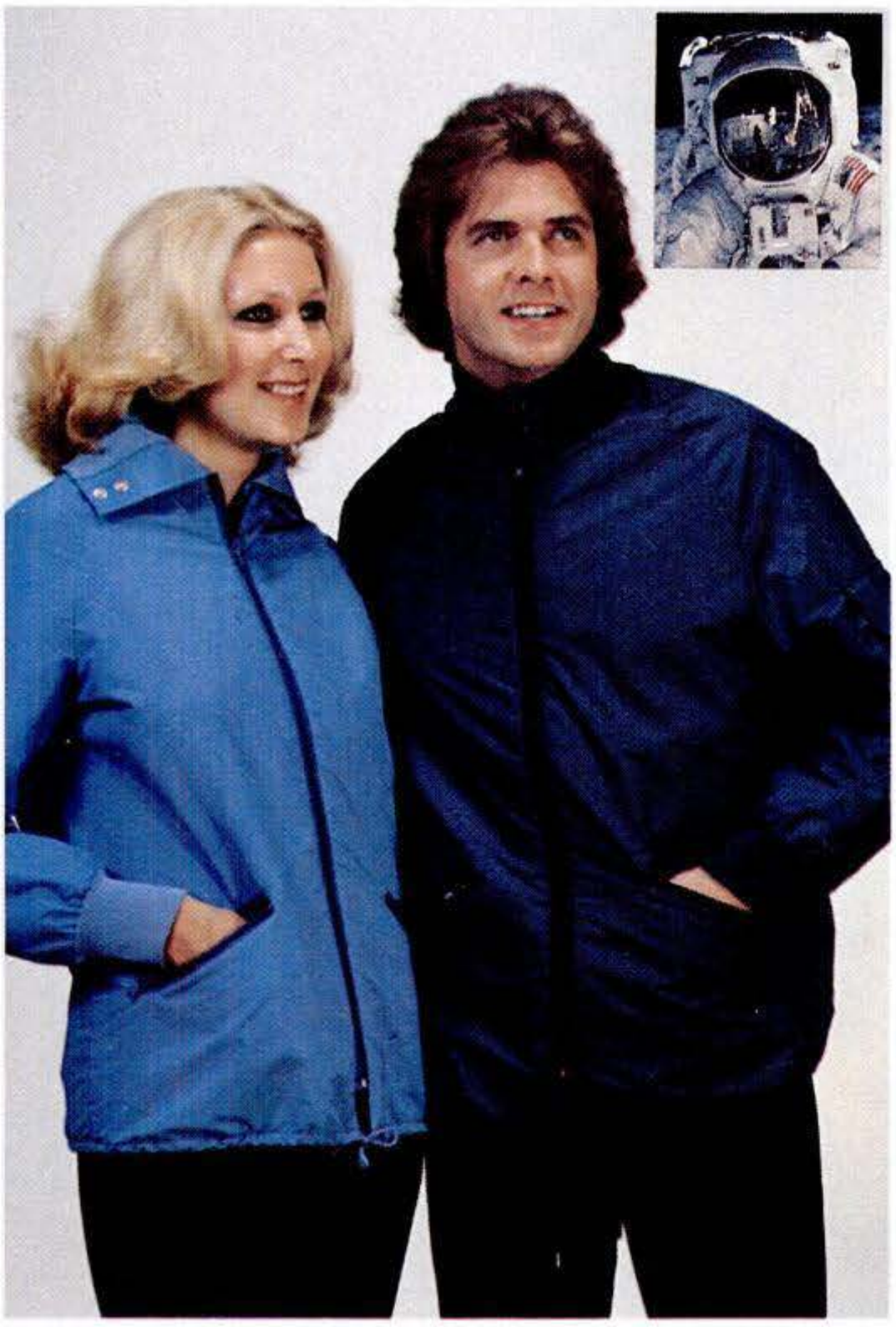

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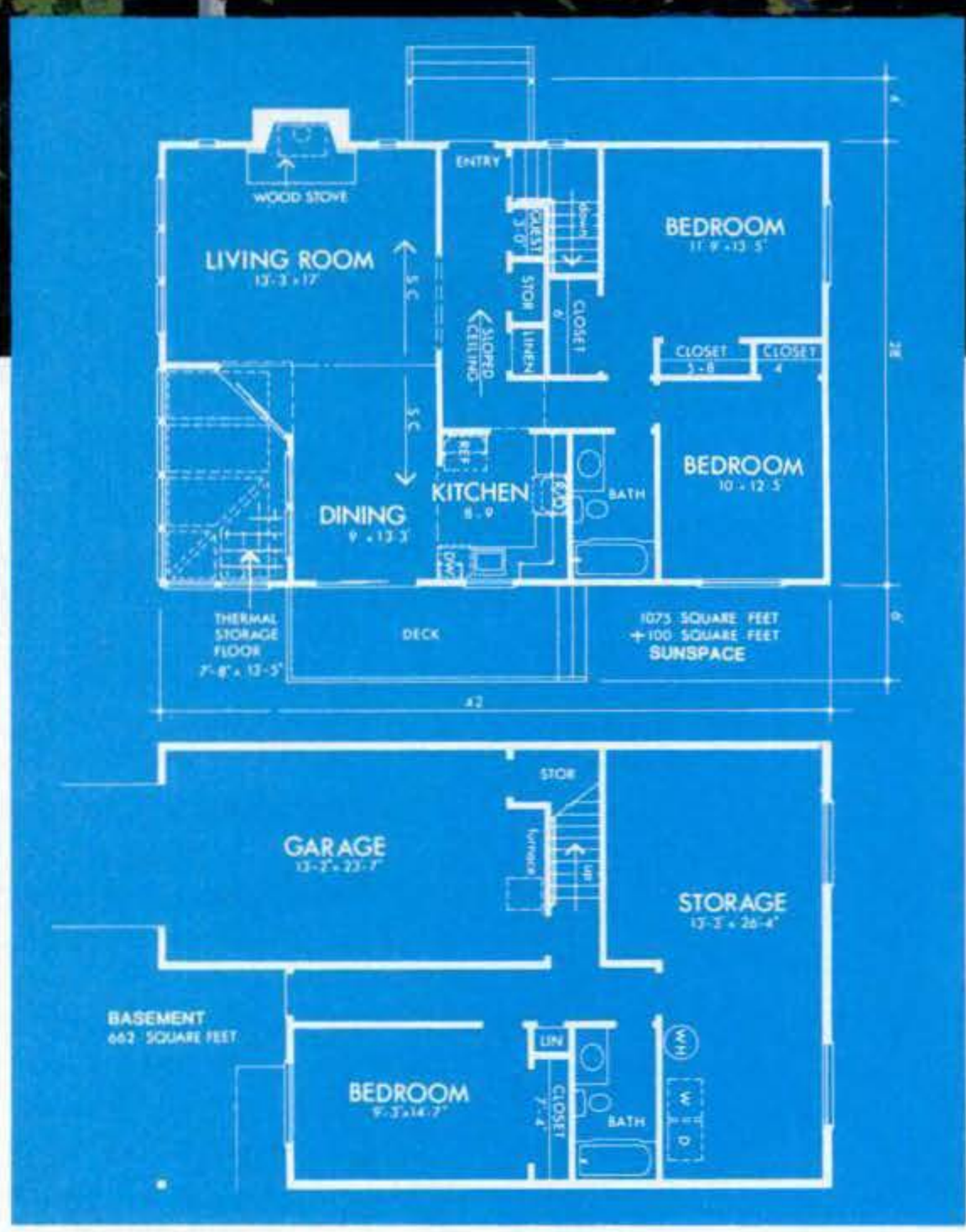
PS leisure-home plan

Floating sunspace



By AL LEES

Most homes that feature a sunspace (that's the term architects now prefer to the awkward and less-than-accurate "solar greenhouse") plant it firmly on the ground. But in most of these new glazed rooms, the growing of plants is strictly optional: The main purpose of the structure is to capture and store solar heat on cool days. For that reason, it may make sense to lift your sunspace well above grade, for optimal solar exposure. Especially at the wooded sites favored by leisure-home builders, upside-down floor plans are popular, because they raise the activity areas (and their adjacent decks) above the foliage for better vistas. Also, if other homes crowd close, stacking the main story on

[Continued on page 164]

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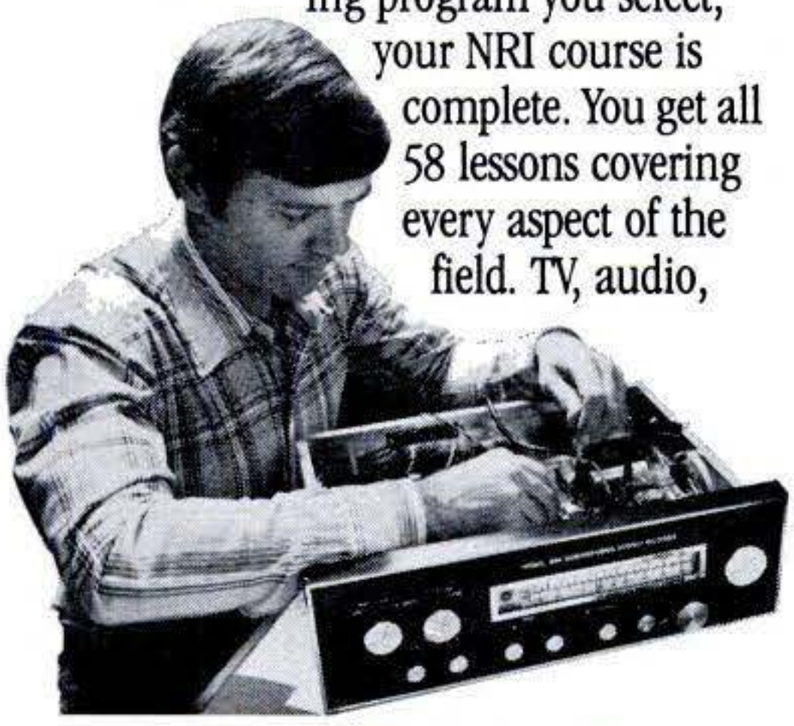

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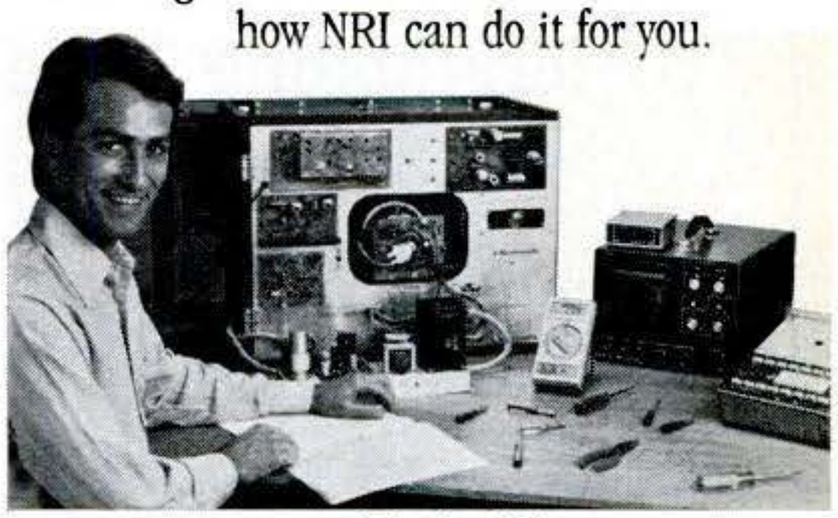

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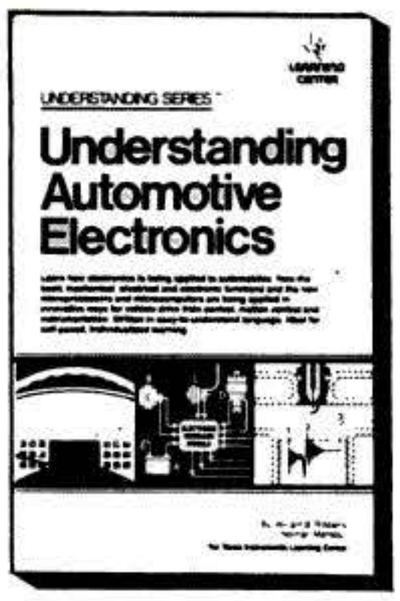

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Under-floor heat bank

[Continued from page 89]

That has always been the Hol Grail of solar architecture. Previous ly, owners of passive-solar house needed a measure of missionary zea They had to be willing to adjust thei life styles to less heat, give up certai amenities (such as north-facing win dows), and put some daily effort int operating the system. Not in Jones' houses. In fact, the family that bough the first under-floor-rock-bed hous had no real interest in solar; they sim ply liked the design of the house.

The outstanding performance an architectural flexibility of Jones' houses both stem from his success i perfecting, through four generation of the design, a thermosiphoning sola system. Thermosiphoning is based o a simple fact: Hot air rises. If its patl is confined in a well-sealed loop an some means is provided to take hea out of the air at one point in the cycl and put it back in at another point, constant flow of air will develop, ris ing and falling without benefit of an other force.

In a thermosiphoning solar system a solar collector puts heat into the ai and a thermal sink of water or rock takes it out. This sort of loop is conve nient for heating houses because th energy in the thermal mass can be re leased when and where it may b needed.

Thermosiphon systems are not new with Jones, of course. The concept car be traced back to the designs o Edward Sylvester Morse in the 1880's The modern evolution of such systems began in 1967 when a solar innovato named Steve Baer designed a sola chimney in Bernalillo, N.M. He fol lowed that with other designs and, i 1972, built the ground-breaking Pau Davis house in Corrales, N.M.

The progression begins

"When I first saw the Davis house i 1976," Jones recalled, "I was struck b the logic and simplicity of the thermo siphon system. Since neither heat col lection nor storage occurs in the livin space, I realized it would be possible t reduce the large temperature swing that typify other kinds of passive solar design."

Jones's first attempt to design suc a system [see "Taking the Myster Out of Passive-Solar Design," PS, Feb '81] was derivative of Baer's work: hybrid system in which a convectiv loop puts heat into a rock bin, the distributes it to the house through fan-forced duct system.

"That first collector and rock bi

were designed on the basis of horseback estimates and trial-and-error tests," Jones says. But as a first try the system was a success (Jones and his family still live in the house), and he was encouraged to attempt a house that would be entirely passive.

To do this, Jones adapted a proposal by Morris to use the rock storage for interior walls of a house. The thermosiphon system would run the same way, driven solely by the temperature difference in the loop, but the air would be routed through large underfloor ducts to several tall, thin cages filled with three- to seven-inch-diameter rocks. Then, when room air cooled below the temperature of the rocks, heat would radiate through the plaster on both sides of the vertical beds.

The house was built using 93,000 pounds of rocks in the steel-framed beds. The convective loop worked well, and the radiant heat offered greater comfort than the forced-air heat of his first design. But there were problems, too. Because the duct lengths varied, some beds got hotter than others, so the house heated unevenly. Also, the cost of hand-filling the beds limited the design's commercial prospects.

New ball game

But now the stage was set for a real winner. Why not lay down the vertical beds, providing the whole house with a continuous radiant floor panel? At first the idea seemed to be a mere extension of the previous design, with just a few parameters needing adjustment. Instead, it turned out to be a new ball game.

The idea required that the rock bed extend under the entire 2,000 square feet of floor area, which, because of the constraints of the site, would have to be designed along the north-south axis. Working out a rock-bed geometry to produce balanced air flows under these conditions proved extremely complex. Jones called in Morris.

The engineer's solution was the ingenious tree-shape duct system illustrated with this article. Unfortunately, building the 18-inch-deep bed and loading it with 110 tons of rocks took a huge amount of hand labor—three weeks' work for four men.

After the house was completed, Morris studied its performance under a contract from the Department of Energy. Its solar-heated fraction—excluding a small contribution from the attached greenhouse—worked out to be 97 percent even though the

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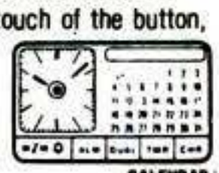
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design goal had been only 85 percent. Similarly, the day-night temperature swings and north-south temperature variations were less than had been predicted.

Part of the reason for those astonishing numbers is that the walls of the house are better insulated and sealed than is usually the case with passive-solar houses that use adobe or concrete-block walls. In the under-floor-rock-bed design there's no need for large amounts of mass above the floor, only for a good thermal cocoon. The result is a house that looks like adobe, but is actually framed. It costs less to build and allows use of more insulation for a reduced heating load.

Blocks replace rocks

But if time and money were saved on the above-ground part of the house, the hand labor of constructing the rock bed still dictated a selling price way up in the stratosphere. Jones recognized that his design would not be truly successful until it was adaptable to the production-house market.

To bring the cost down, he next attempted substituting concrete block for some of the rocks. The newest design uses a tree layout similar to its predecessor, but the bottom 10 inches of rock are replaced by blocks laid loosely on their sides so their hollow cores provide air-flow passages through the bed. Above the block a layer of rocks is still used, but these, it turns out, can be placed by an ordinary backhoe at a great saving of time and labor. "The block gives us a large amount of mass for a small amount of dollars," Jones said.

Two of these second-generation under-floor-rock-bed houses have now been built. Their performance has not been measured, but Jones is confident that they will approach the success of the first-generation house. If he's right, his company should have no difficulty selling them in the middle range of Santa Fe's housing market.

Like all of Jones's houses, these were built on speculation. Jones prefers to work that way, claiming that it gives him the freedom to develop innovative designs. Of course, there are risks, too.

"We're sticking our neck out about as far as it will go to put these projects together," he told me. "But we're demonstrating that it's possible to use passive design and compete in the marketplace. In fact, we think we can beat the guys building conventional houses on their own terms." PS

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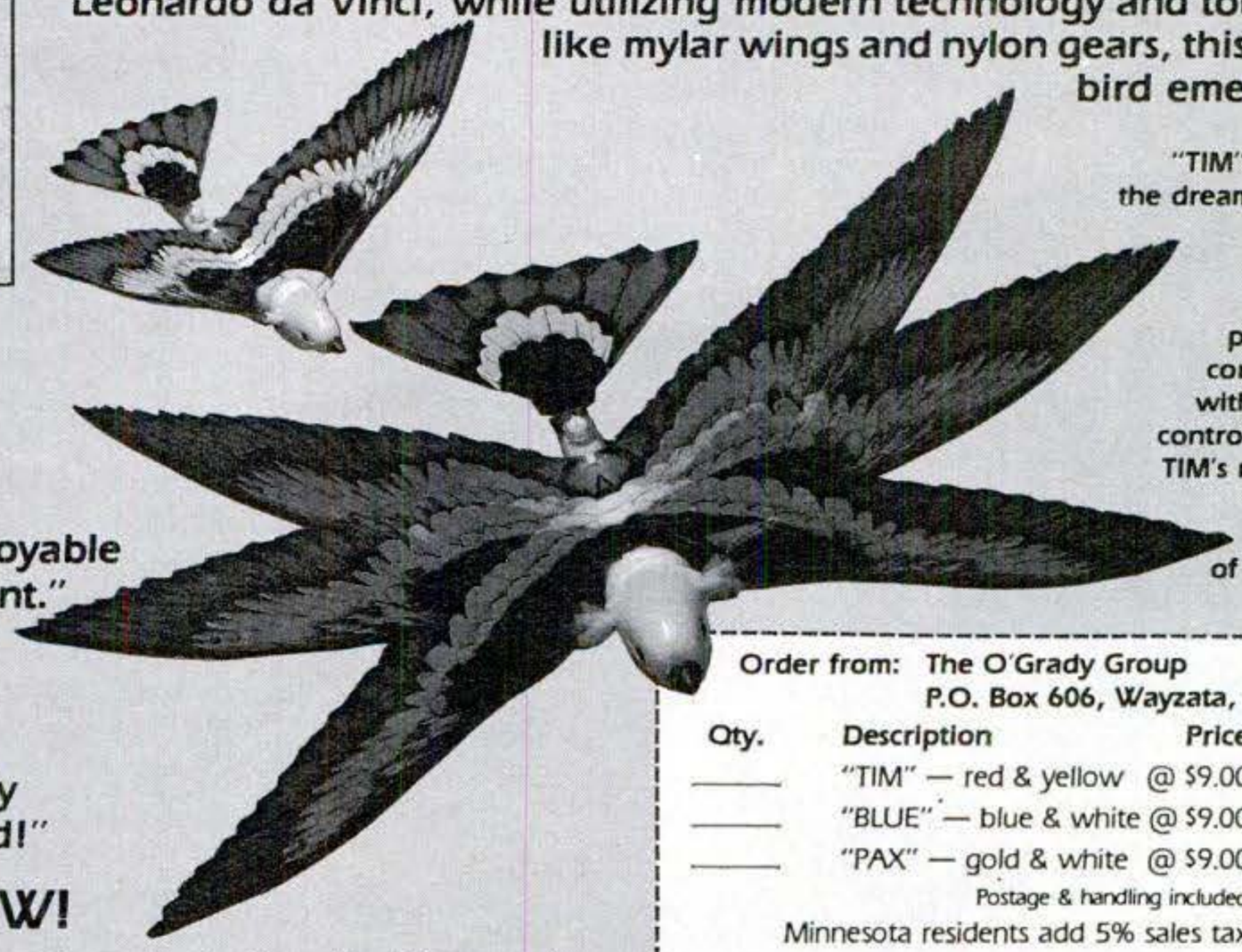

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[Continued from page 105]

injection system is still undecided. Brouwers says they need 12,000- to 14,000-psi injection pressure. Berenyi said that was because the air in the combustion chamber was quiescent, and the high pressure was necessary to distribute the fuel in the combustion air. Compared with typical automotive and industrial diesels, which use injection pressures under 2,000 psi, that's a lot of pressure.

One approach, says Berenyi, might be to use a hydraulic amplifier injection pump for each cylinder. A main pump supplies fuel to each amplifier pump at about 3,000 psi. The amplifier, as the name implies, steps up the pressure to the injector to the desired 12,000 to 14,000 psi. Ultimately, all the injection controls would be electronic to avoid complex linkages and mechanical adjustments.

Ceramic cylinder liners and pistons running without cooling may be used in advanced models of the diesel radial. [See "The Coming Age of Ceramic Engines," PS, March.] The object is to make maximum use of heat as a working medium rather than waste 70 percent or more via cooling fins. The problem, since the beginning of internal combustion engines, has been the critical limits of metal parts with respect to heat. Ceramics can take the heat and theoretically should make for significantly more efficient engines.

Eventually, Teledyne may use ceramics in the engines intended for twin-engine corporate aircraft whose owners can afford the more complex engines. The smaller engines for single-engine personal aircraft may remain metallic for some time until ceramics become truly acceptable in engine structural components.

Steve Berenyi pointed to the possible lack of acceptance of ceramics for some years. "The aircraft industry doesn't want any crockery engines today," he said.

As now planned, there will be two new Teledyne engines: one about 200 hp for single-engine planes, the other about 400 hp for twin-engine executive-type planes. But their designs are so new, using technologies just now shaping up, that they will have to be produced in evolving stages. The first prototype models, using the basic radial, two-stroke, low-compression diesel configuration, are expected to fly in about 1985. A second generation should be taking off about 1990. The most advanced designs probably won't see the skies for another decade.

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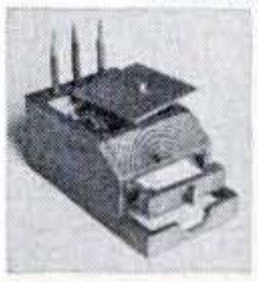

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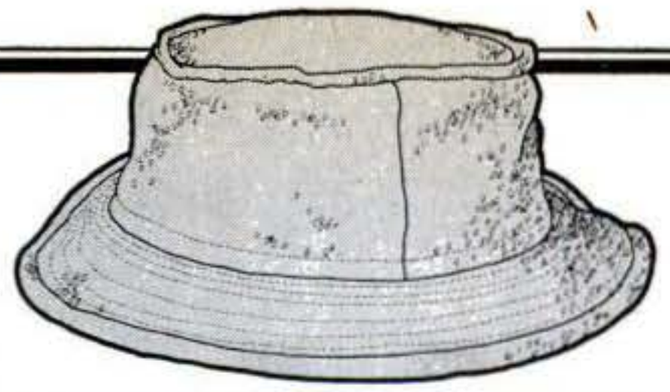

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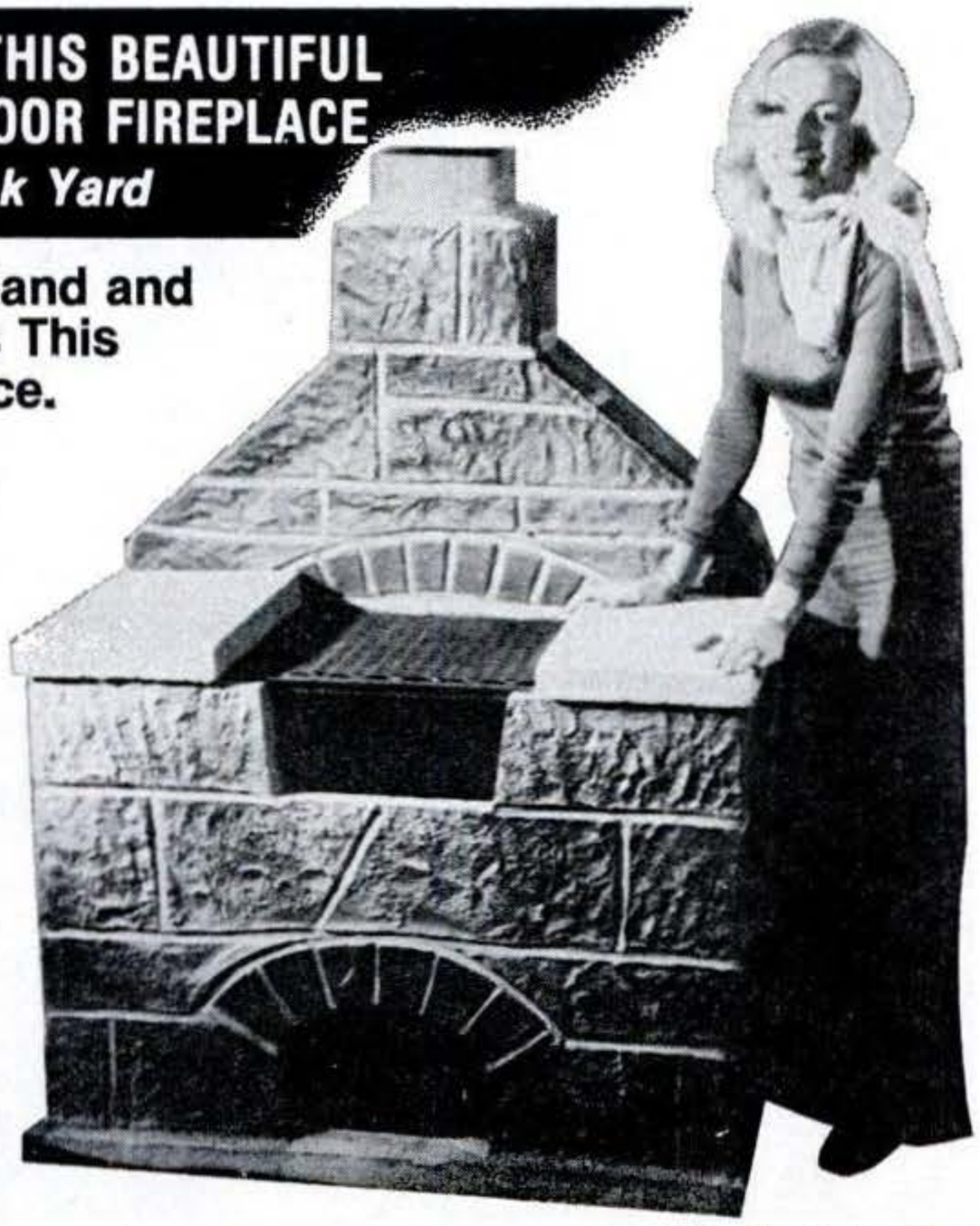

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Bad-weather gear

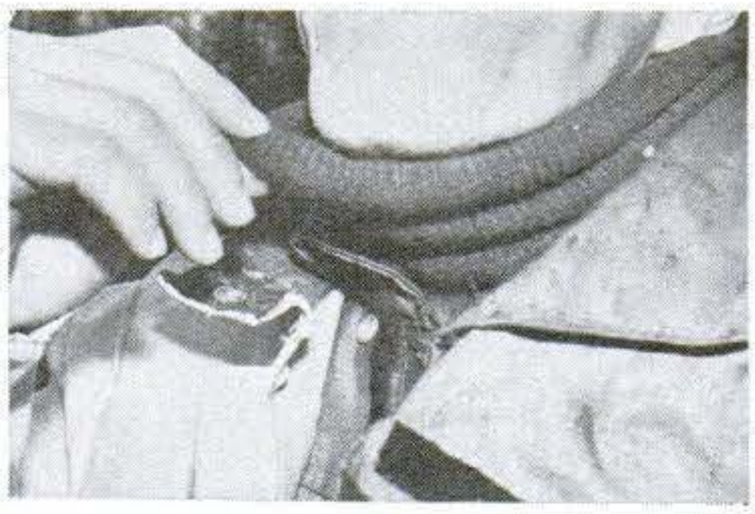
Riding in dry weather with 75-degree-F temperatures is nice. But nature being what it is, some days are cold and wet. Three items I've used for several weeks (photos below) will be of great use to you on those days.

Rukka rain suit. New to the U.S., this is one of Europe's best-selling rain suits. That's probably because it works so well. I rode 200 miles in a downpour on a fully faired bike, and my clothes stayed dry. I went 10 miles in a light rain on an unfaired bike and didn't get wet, either. The fabric is polyamide fiber coated with softened PVC. Seams are welded (no thread holes to let water seep through). It has a clear, waterproof map pocket on the thigh and another waterproof pocket behind that one. This is the best rain suit I've ever used. I heartily recommend it.

Neck dickey. After I used this on some cold days, I wondered how I ever got along without it before. It's made of stretchable acrylic (one size fits all) and does an excellent job of keeping the wind off your neck. You slip it on before you put on your riding jacket.

Thurlow sport touring gauntlets. Made of hand-crafted deerskin, these stylish gloves are made for the sporting rider who travels in cold, but not freezing, weather. A thermal lining keeps your hands warm until the temperature drops below 45 degrees F. Their seamless palms and pliability let you feel the handlebar controls with more sensitivity than with ski gloves or mittens. The gloves have a 12-month guarantee covering workmanship and wearing quality.

Each of these items is sold by Bavarian Cycle Works, 385 Eighth St., San Francisco, Calif. 94103. The rain suit is imported from Finland, costs $108. The dickey is $5.95; the gloves, $56.50.

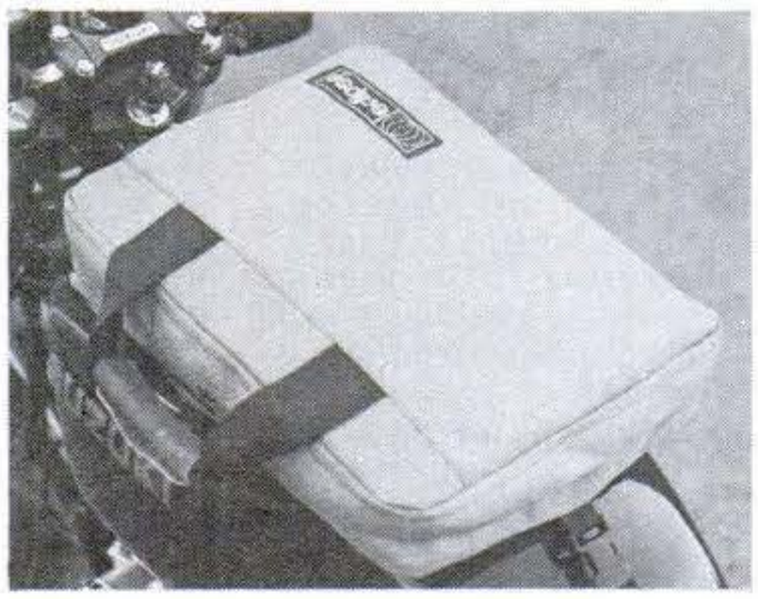


Belt-drive motorcycles

Kawasaki offers three motorcycles this year with a belt final drive: the KZ 250, KZ 305 (shown here), and KZ 440. The belt needs no lubrication, rarely needs adjustment, and runs quietly. Kawasaki is the only company to offer belt drive on a small motorcycle.

Motorcycle briefcase

This detachable briefcase fits on your bike's gas tank while you're traveling. It has a leather handle and is made of Cordura nylon by Eclipse, Inc. (Box 7370, Ann Arbor, Mich. 48107). Cost: $55. PS



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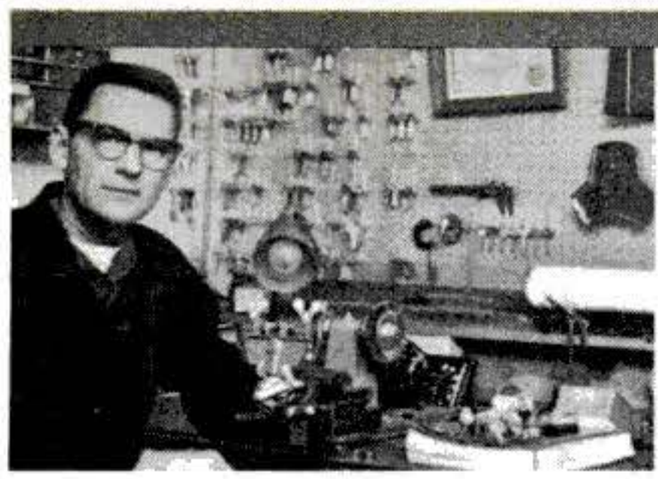

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DEALER INQUIRIES INVITED

Floating sunspace

[Continued from page 152]

top improves both your views and your privacy. You'll appreciate the latter even more if you use your glass corner for sunbathing.

So this month's clever, contemporary design notches its walk-in passive collector into one corner of the second floor, and "floats" it on a single pole. If your country site doesn't call for this feature, order the plans that omit the foundation story altogether and drop the basic floor plan—including the sunspace—back to ground level (turn back to the opening page for ordering data).

Either way, the sunspace boasts a 100-sq.-ft., tile-finished, four-inch-thick masonry floor for natural heat storage. A sliding glass door in the adjacent dining-room wall adds its own solar gain while also providing access to the deck for outdoor dining in summer. (Note the deck is placed on the east wall to catch the morning sun and to provide shade for afternoon lounging and cool, summertime evening meals.)

This is another energy-conscious plan created for POPULAR SCIENCE by Ken Gephart of Home Building Plan Service, in cooperation with Western Wood Products Assn. HBPS plans are designed to satisfy all requirements of the Uniform Building Code, so should give no problems when filed for local permits.

Cathedral ceilings add drama to the living-dining area—and to the entry hall, where the sloped ceiling juts on past the ridge to create a dormer for clerestory windows. Guest, storage, and linen closets line this hallway, and stairs lead down to the daylight basement (except in the single-story version of the plans). This lower level is scaled for a bedroom, bath, and utility/storage, as shown on the floor plan, but could be left unfinished until later if preferred.

The central hall leads to all rooms without annoying cross-traffic. The two main-floor bedrooms are set off from the activity areas—for privacy and peace—and share a full bath (which backs up to the kitchen for efficient plumbing runs).

Vertical 1×4-board paneling, a large boxed chimney, and the window detailing give this small, efficient house its modern good looks. At 1,025 sq. ft., it will fit nicely on the most modest site. And—if you face it south—that sunspace will keep it cozy all winter, with help from a masonry-backed wood stove in the living room.

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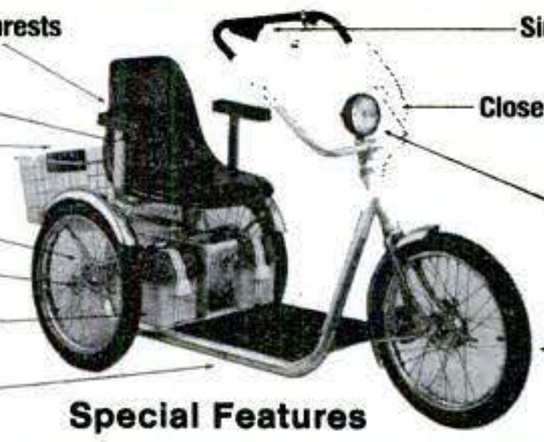

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Folding sawbuck

grips small logs with a vise

Easier, safer sawing is the bonus with this easy-to-make buck

By NEIL SODERSTROM

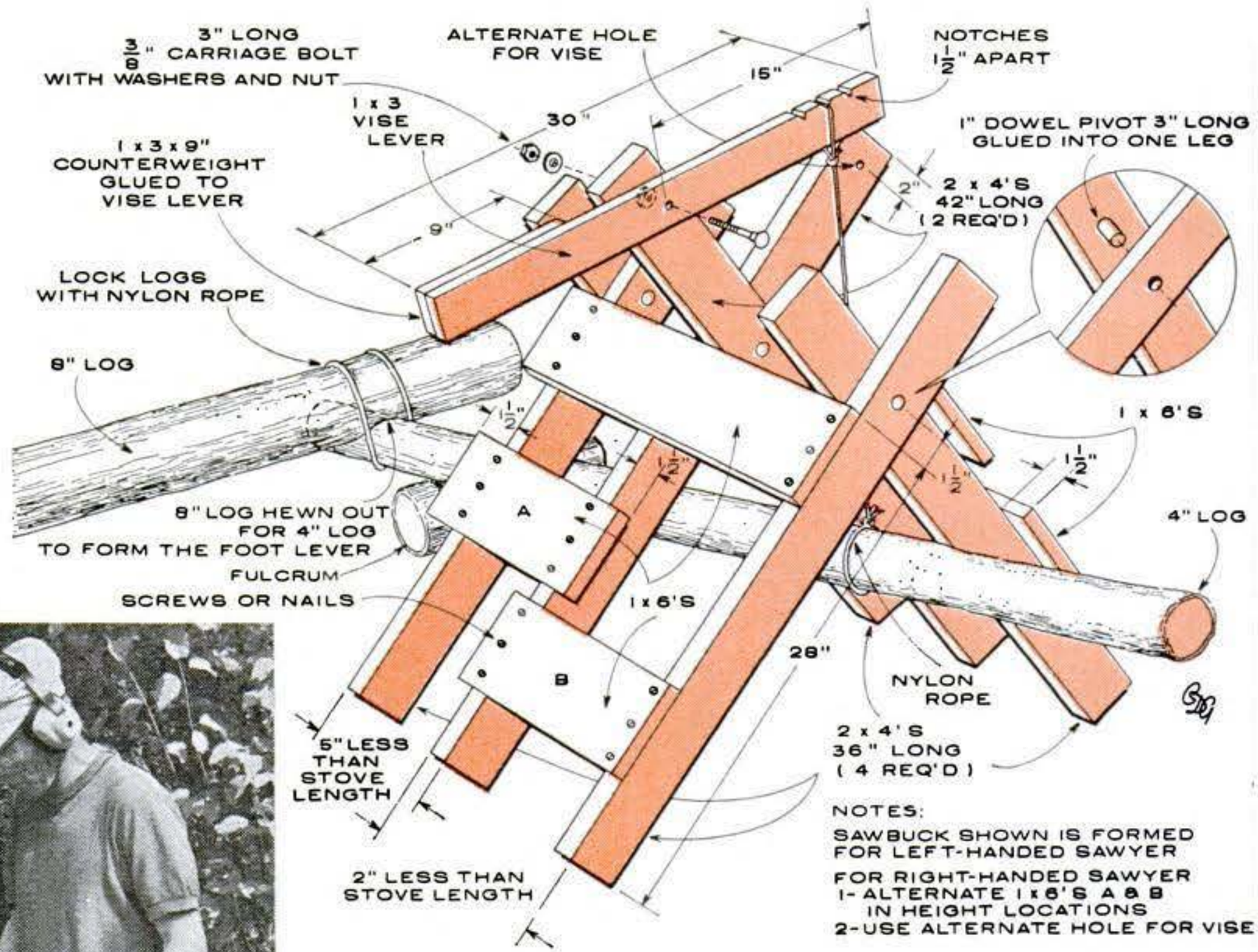
Ever try to saw a small loose log with your chain or bow saw? The log chatters, bounces, and spins, making the job difficult—and sometimes dangerous. You can eliminate the problem by building this sawbuck, which holds small logs in a vise. It's sturdy enough to handle larger logs, too. The rule of thumb: If you can lift it, the buck can hold it. It also folds flat for easy storage.

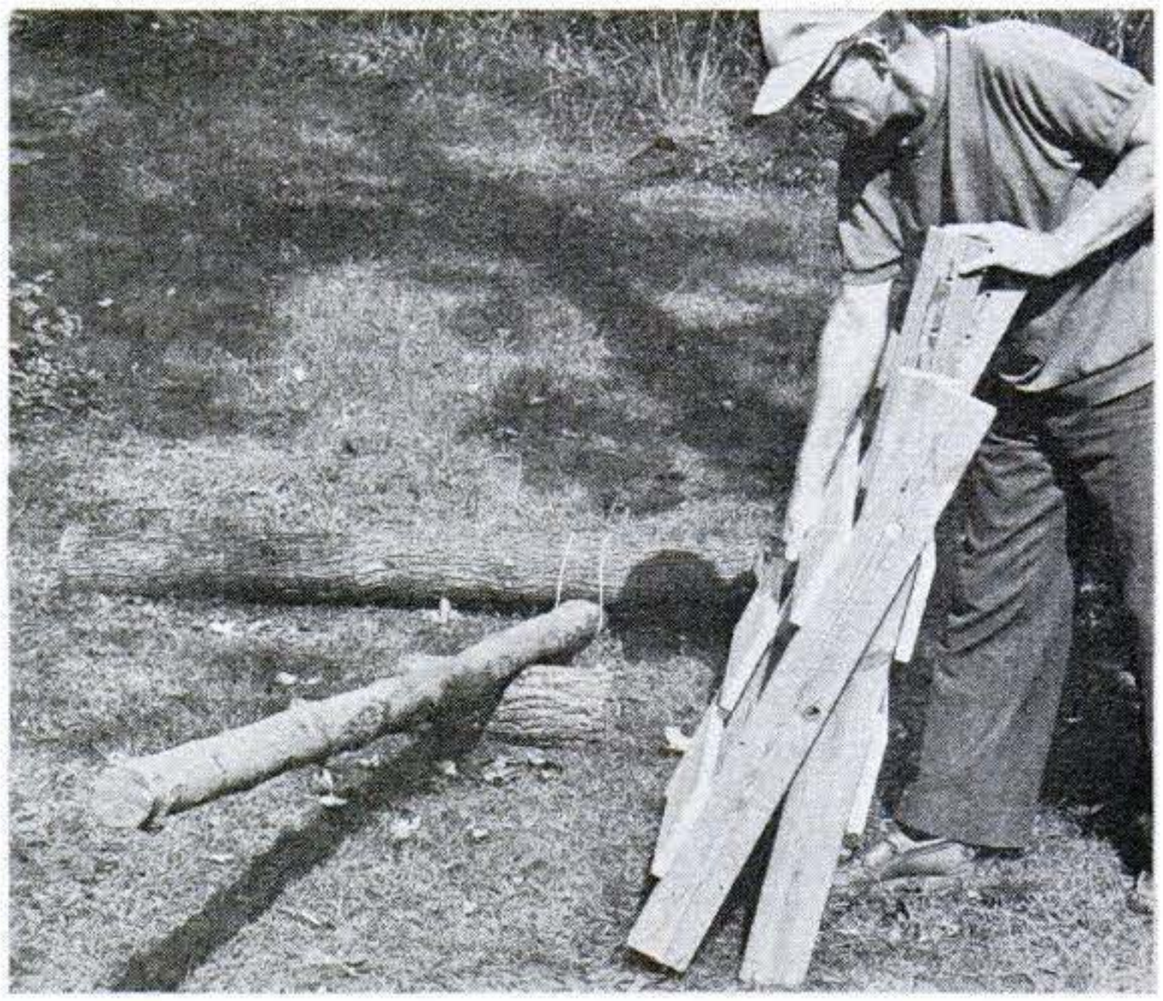
Buck parts can be fashioned from scrap 2×4's and 1×6's, three short dowels cut from an old broom handle, and 42 2½-inch No. 10 galvanized flathead screws. If you expect to leave the buck out in wet weather, treat the raw lumber with preservative or invest in pressure-treated lumber.

Vise parts consist of scrap 1×3's, a three-inch-long carriage bolt, two washers with a nut, two three-foot lengths of nylon cord, and a few logs from your woodpile to make up the lever apparatus.

Although it's okay to use a carriage bolt in the vise (because the saw won't come close to it if you cut the log to stove-wood length), don't use bolts in place of the wooden dowels as pins for crossing the sawbuck's 2×4's. Both bolts would lie in the path of a misguided chain saw. A bolt could damage the chain and perhaps even break it.

This little beauty doesn't take long to build. And once you're finished, you've got a sawbuck that will not only hold larger logs but keep those bouncing branches from being such a hassle to buck. PS





Sawbuck operates simply and effectively: Left foot pressing down on lever closes vise on small log, holding it firmly in place; once foot is removed, weight on other end of lever causes rig to release its grip. To open sawbuck, set one pair of legs on ground, swing other pair outward (right). Center unit over lever.

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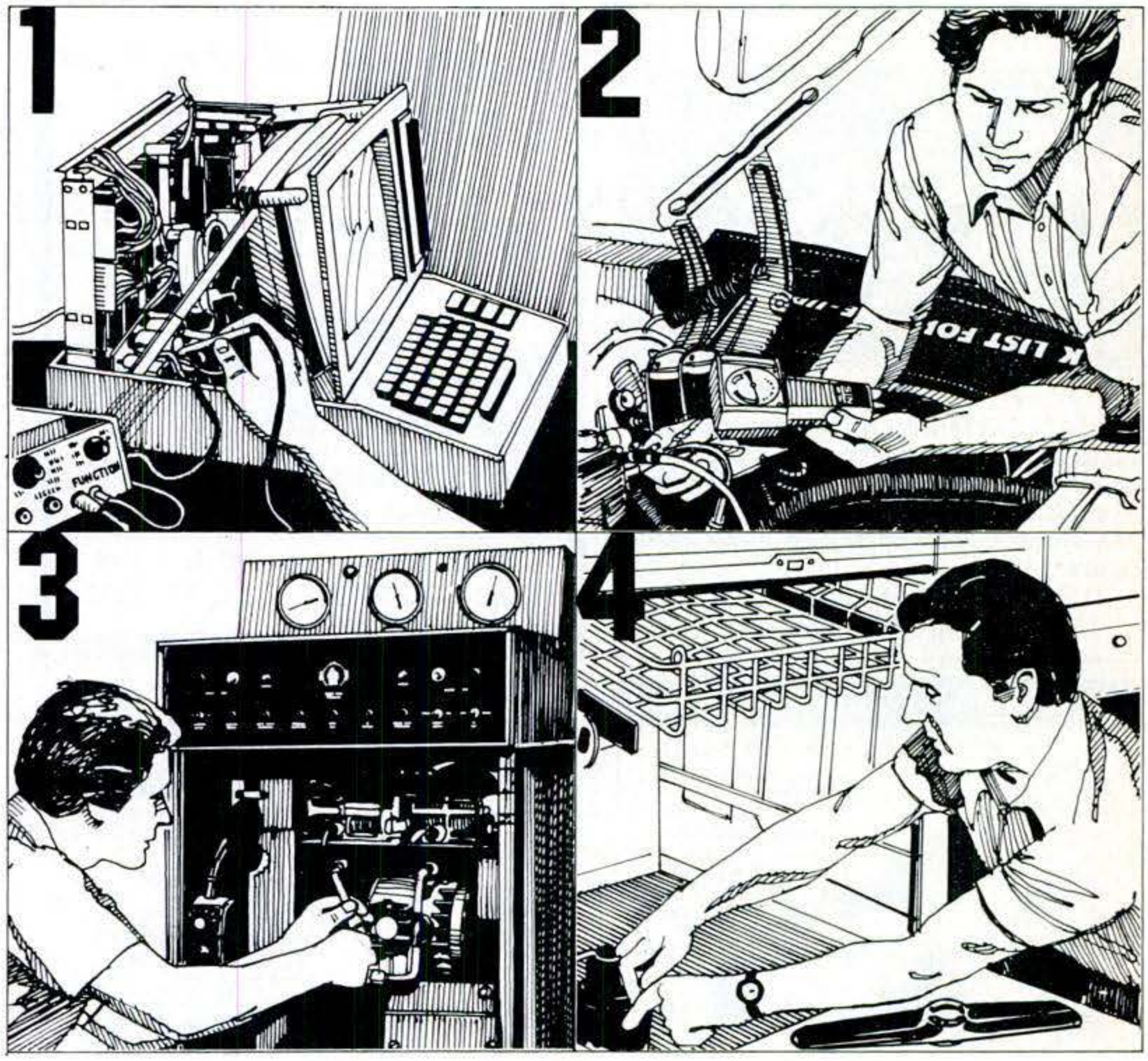

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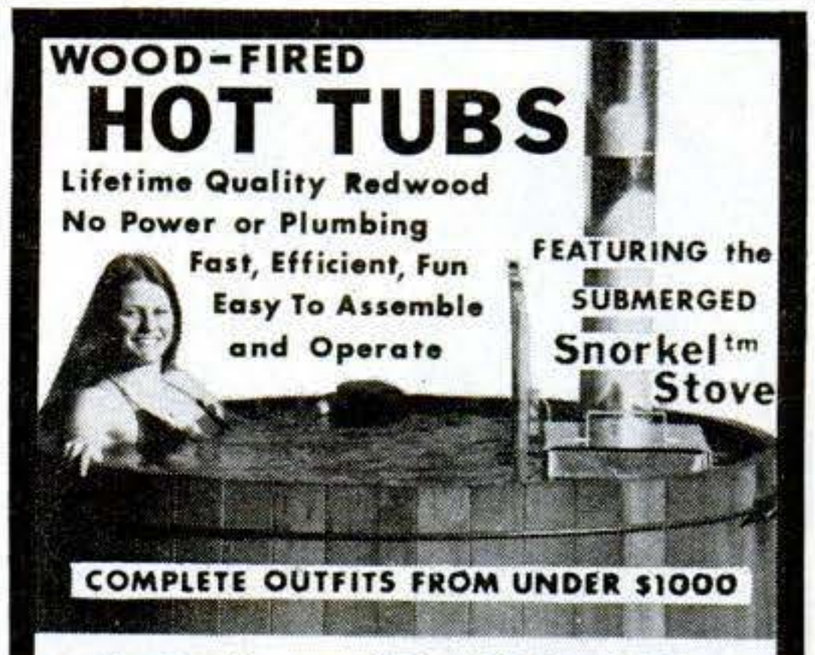

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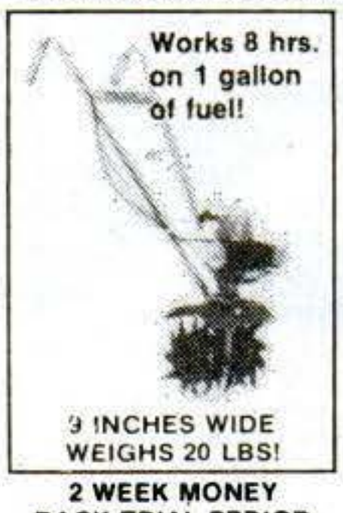

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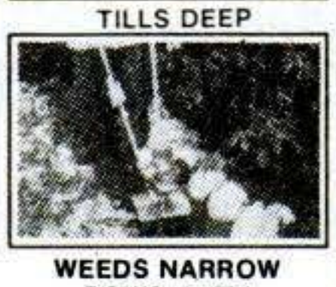

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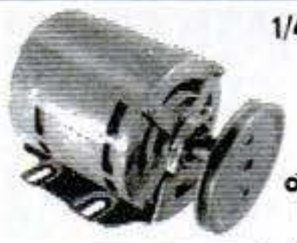

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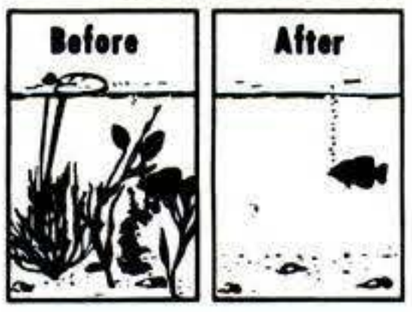

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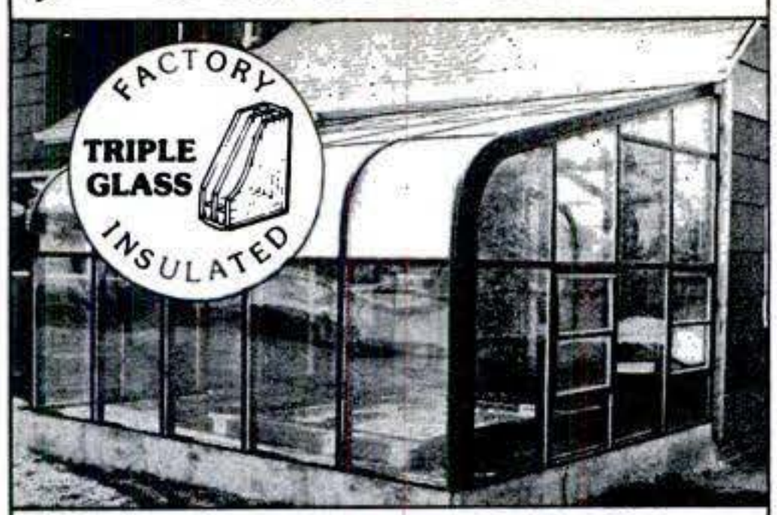

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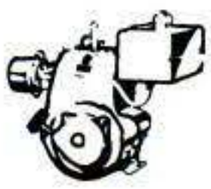

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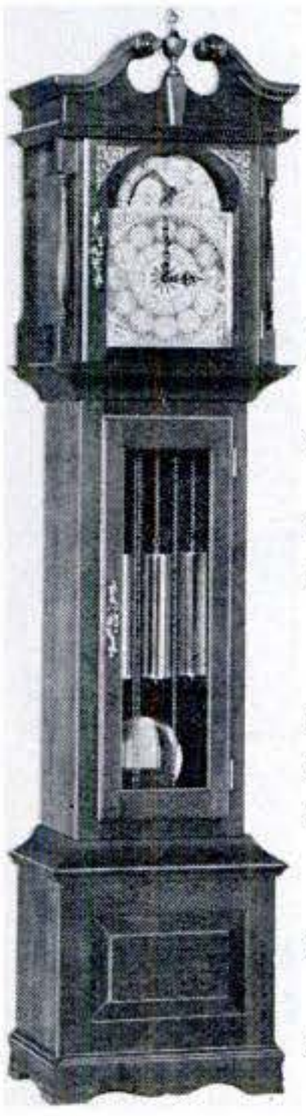

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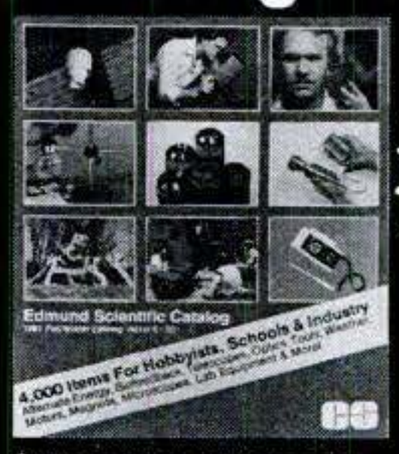

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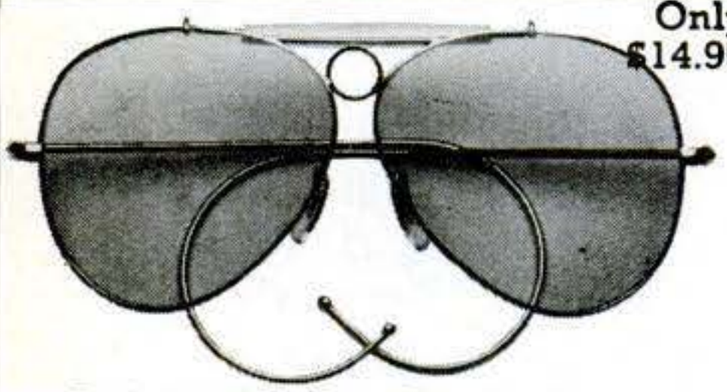

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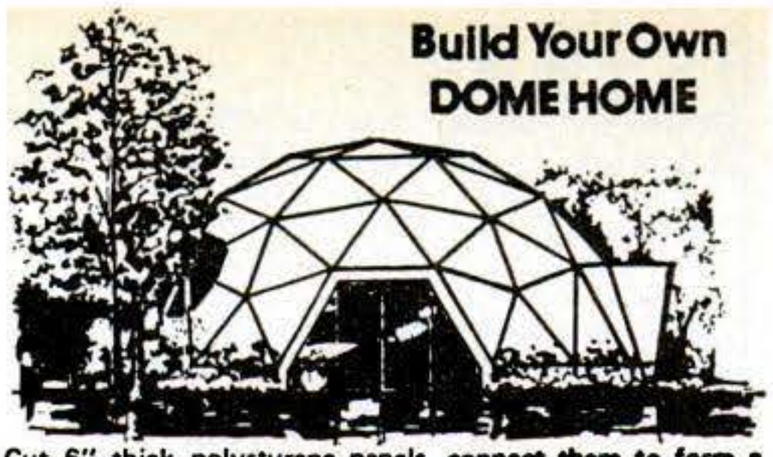

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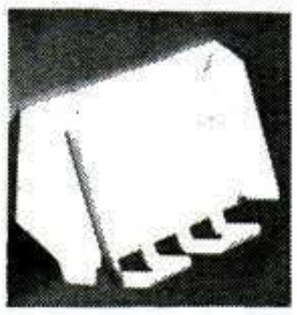

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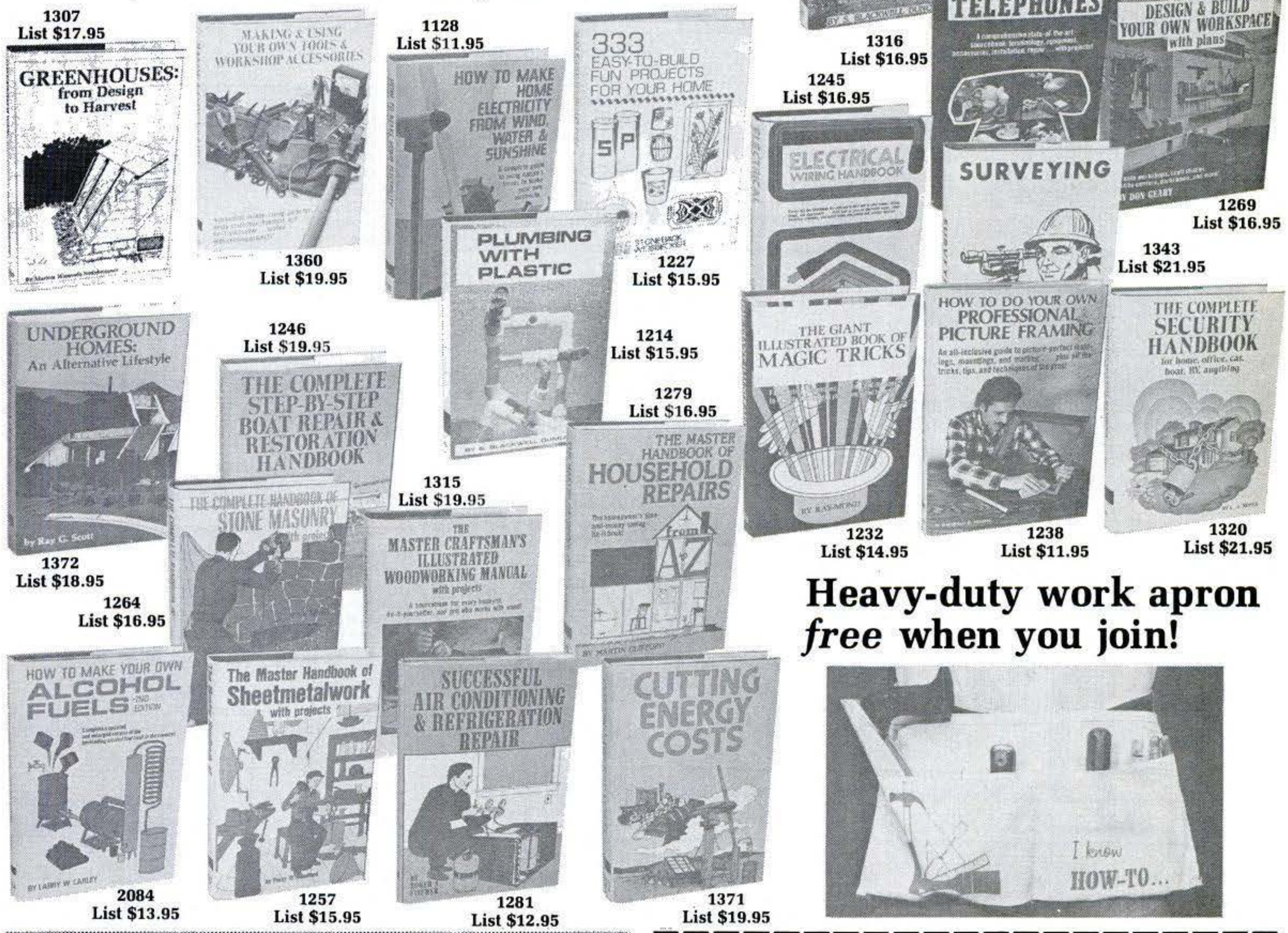

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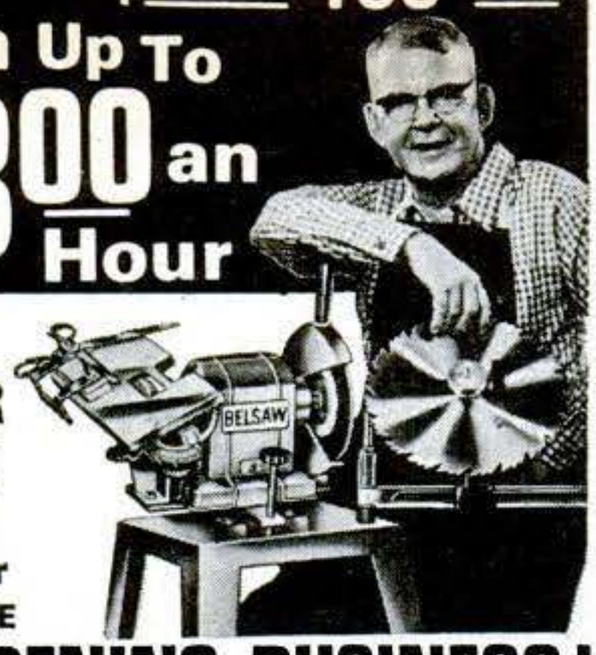

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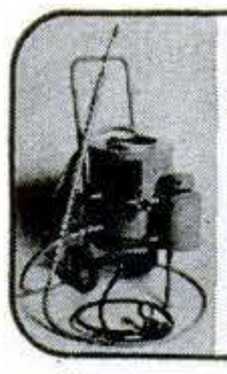

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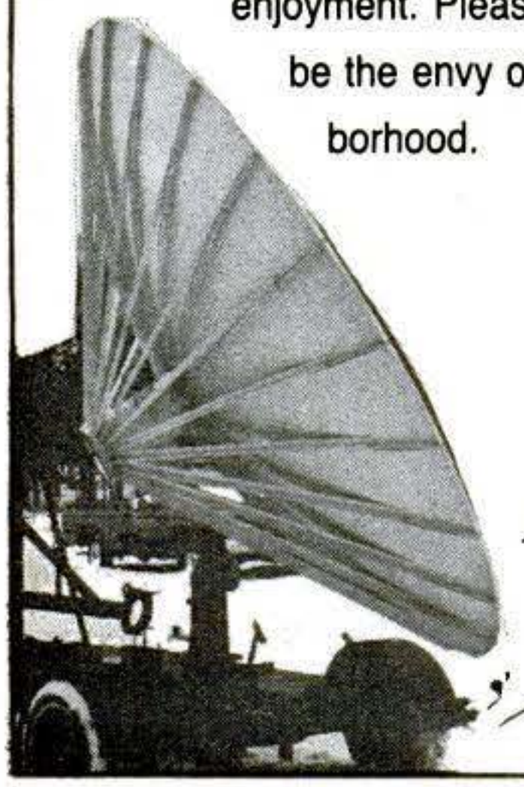

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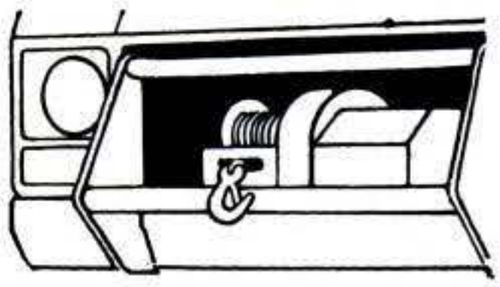

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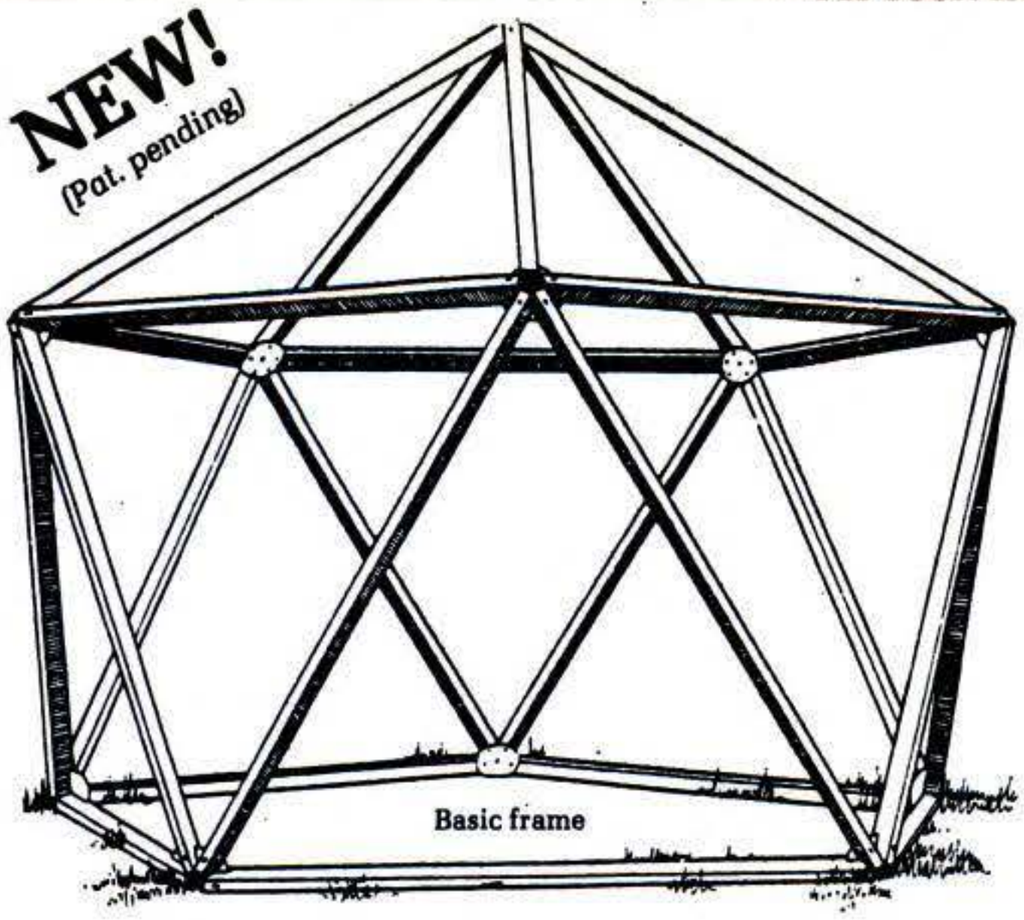

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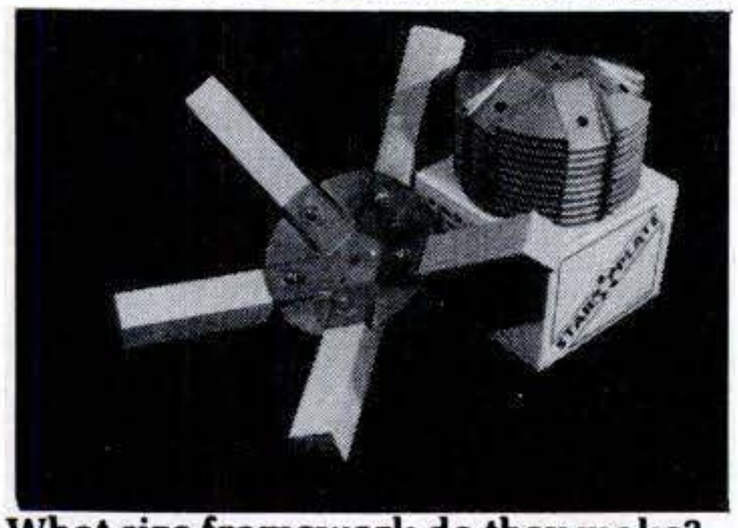

What size framework do they make?

Any size you want. STAR*PLATES hold 25 equal-length struts together. If the struts are short, say 2-3 feet, you've built something small like a dog house or small playhouse. If they're 9 feet long, you've built yourself a greenhouse or back-40 hideaway. The framework is made of 15 triangles, all exactly the same.

Is it hard to build?

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How can I finish it off?

Any way you want to. Some STAR*PLATE buildings are elaborate, with shingled roofs, clapboard sides, and fancy doors and windows. Others are merely covered with canvas and used as beach cabanas, or with plastic to make greenhouses. One customer told us he was going to thatch his with palm leaves! You can make it as plain or as fancy as you want to.

Could I build a full-size geodesic dome house?

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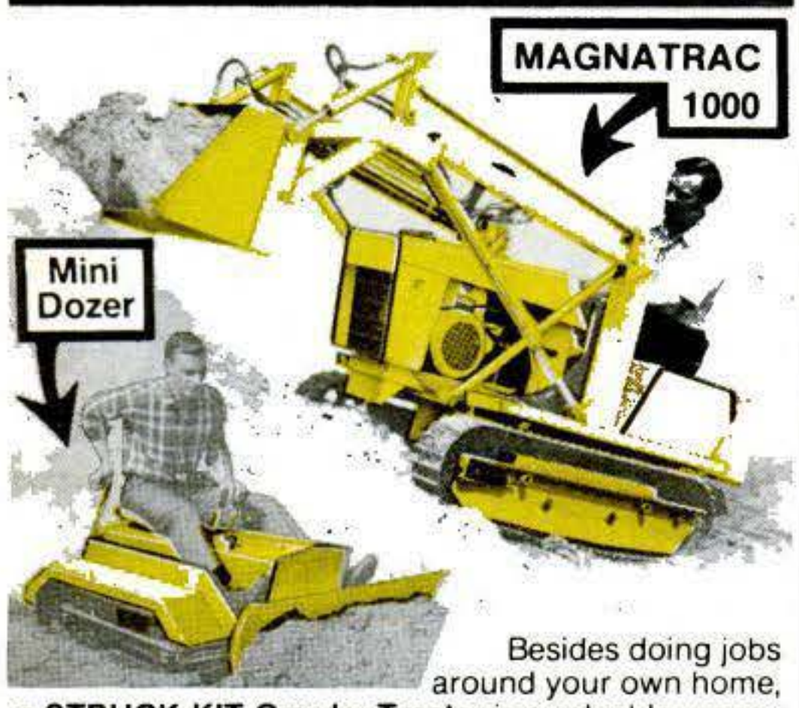

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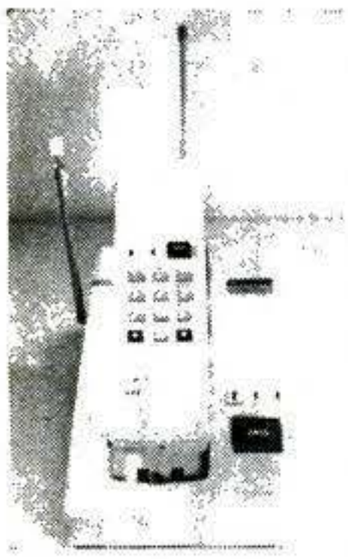

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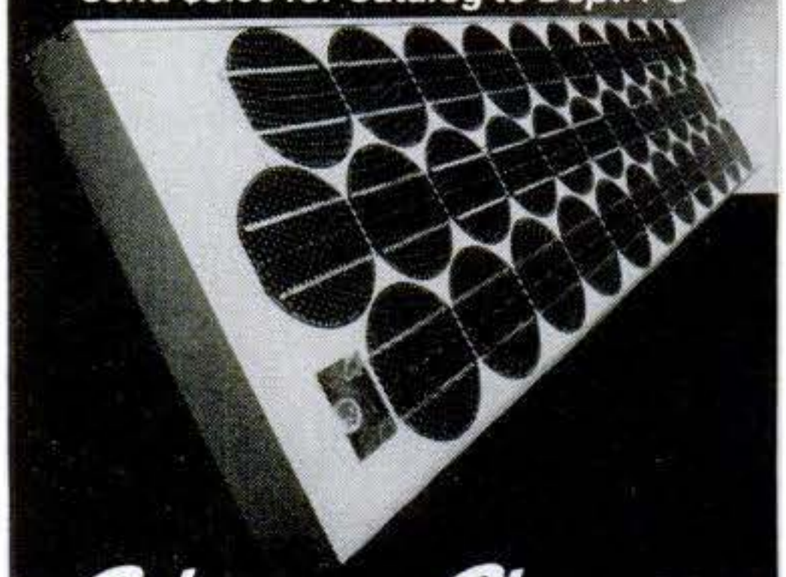

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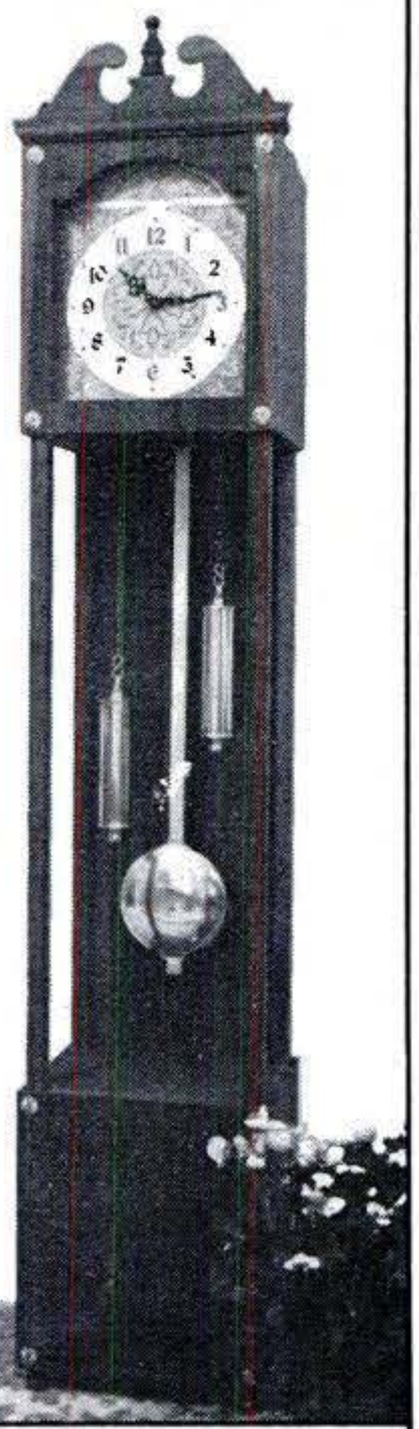

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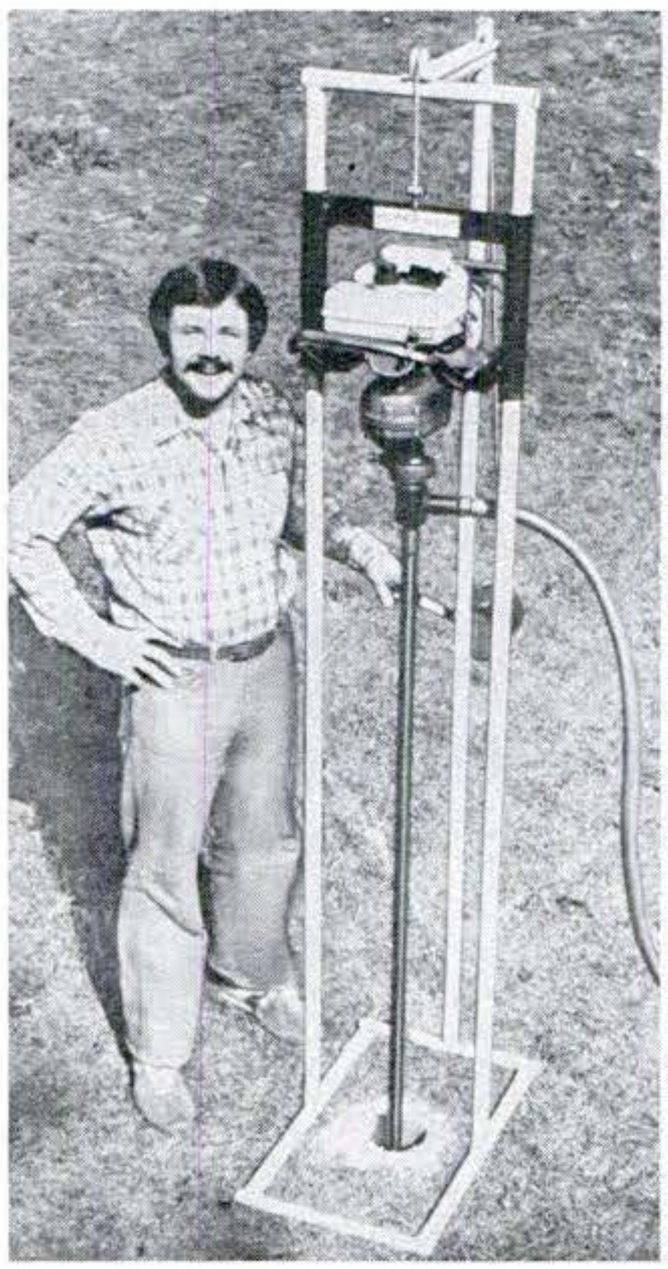

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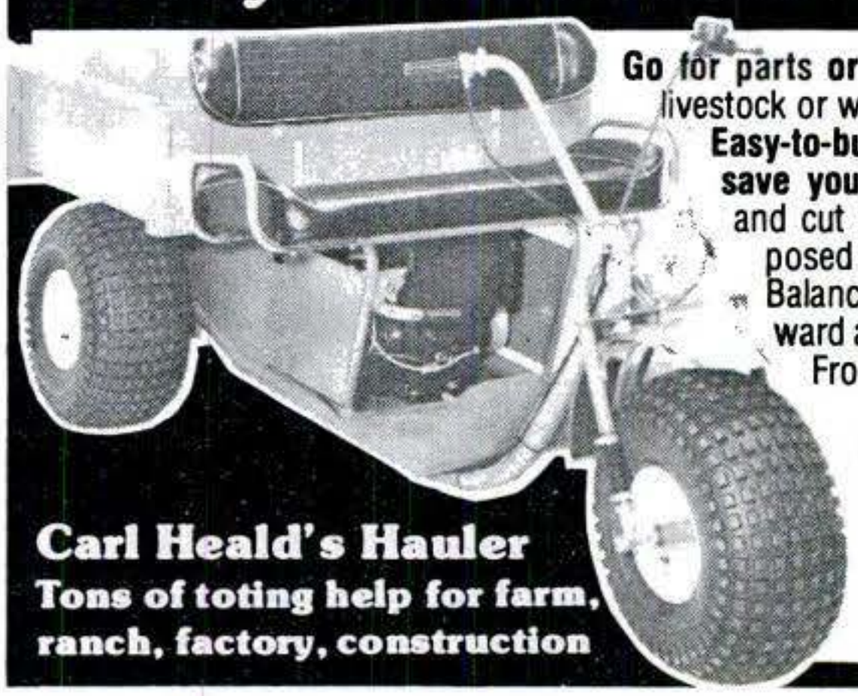

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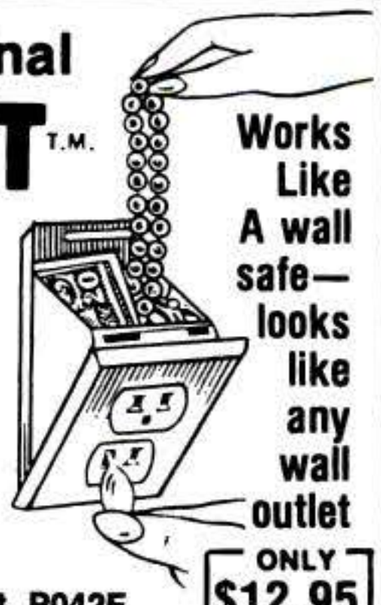

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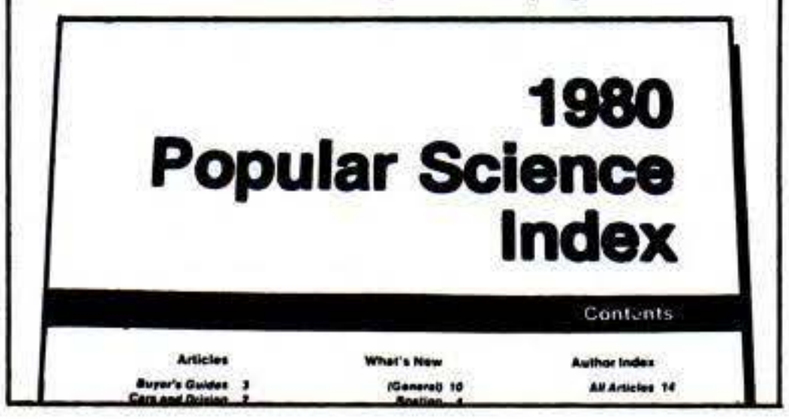

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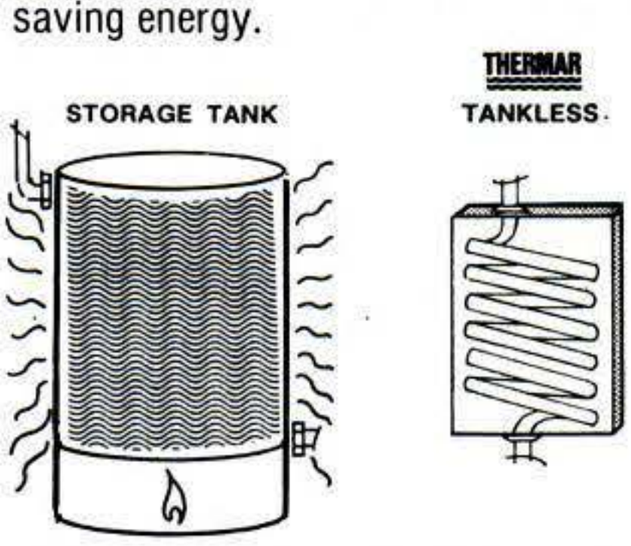

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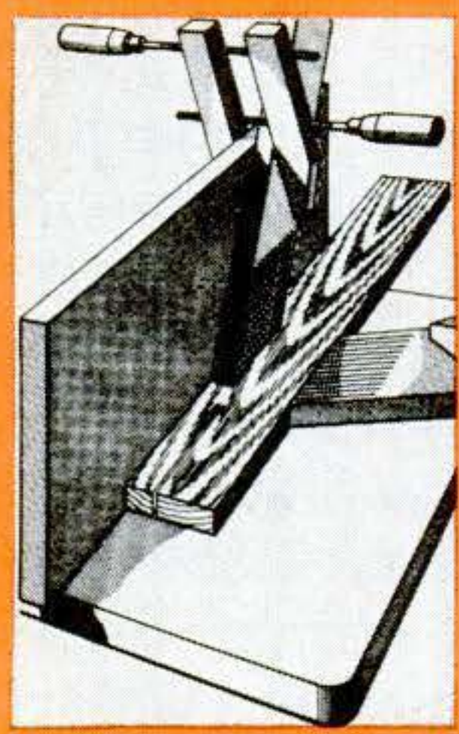
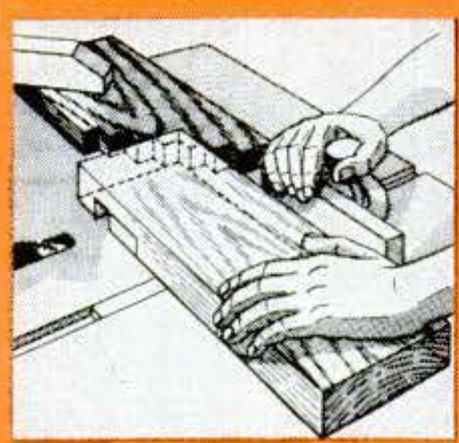
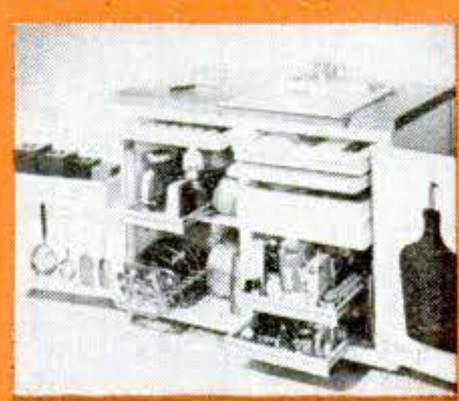


Use this setup for ripping long, thin stock.

Making a compound miter cut.



Use a notched stop block to control the width of cut for a lap joint.



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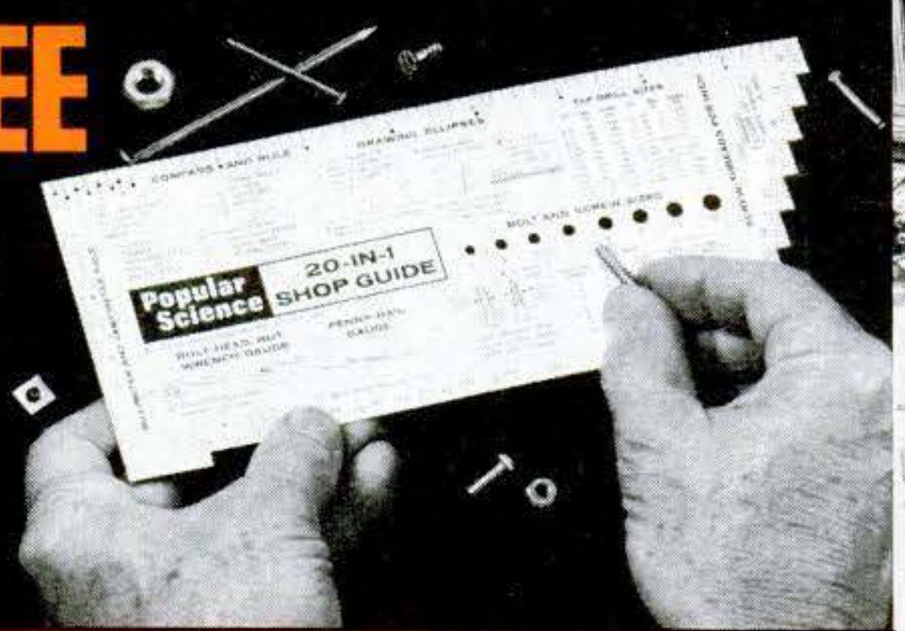

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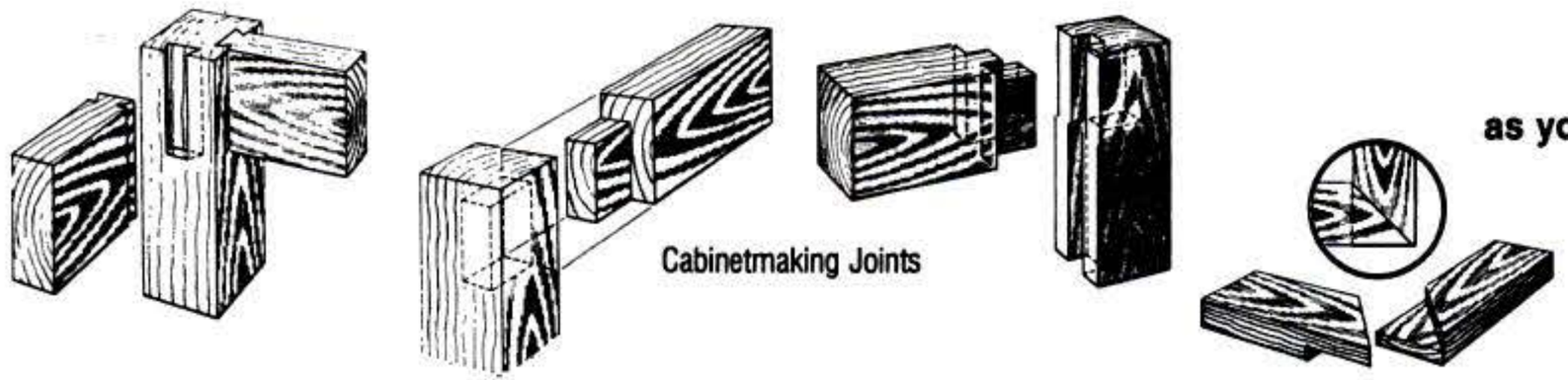

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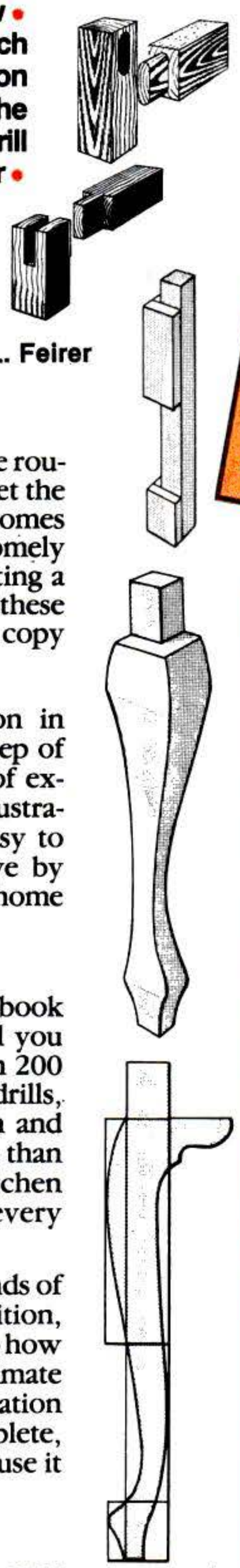

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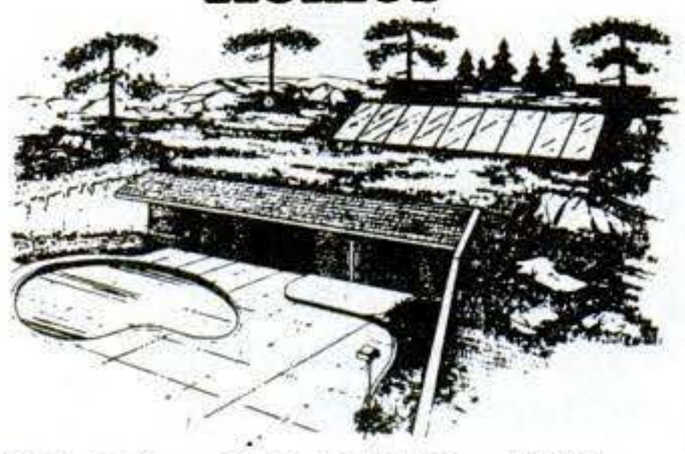

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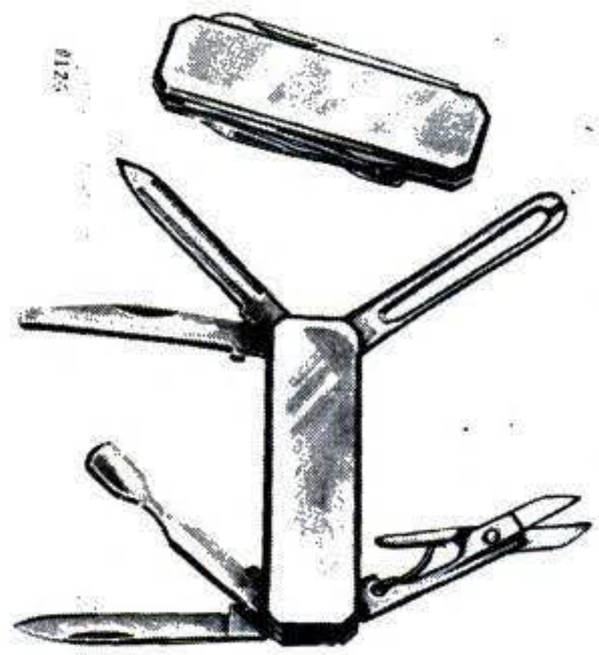

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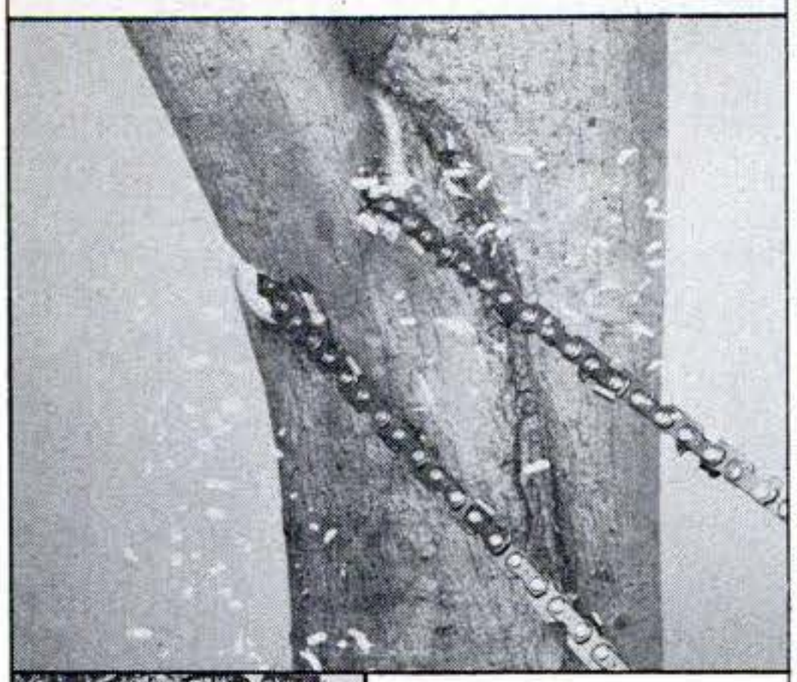

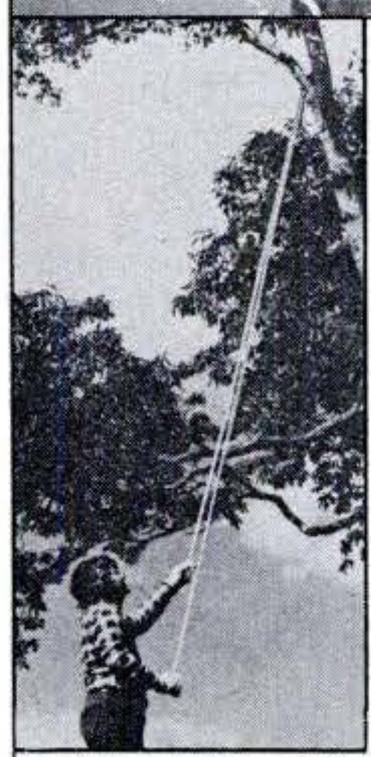

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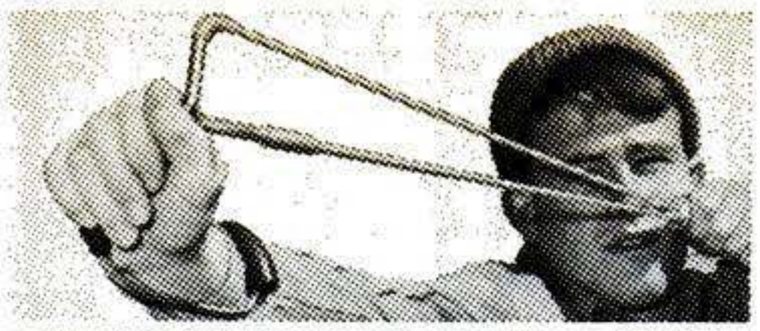

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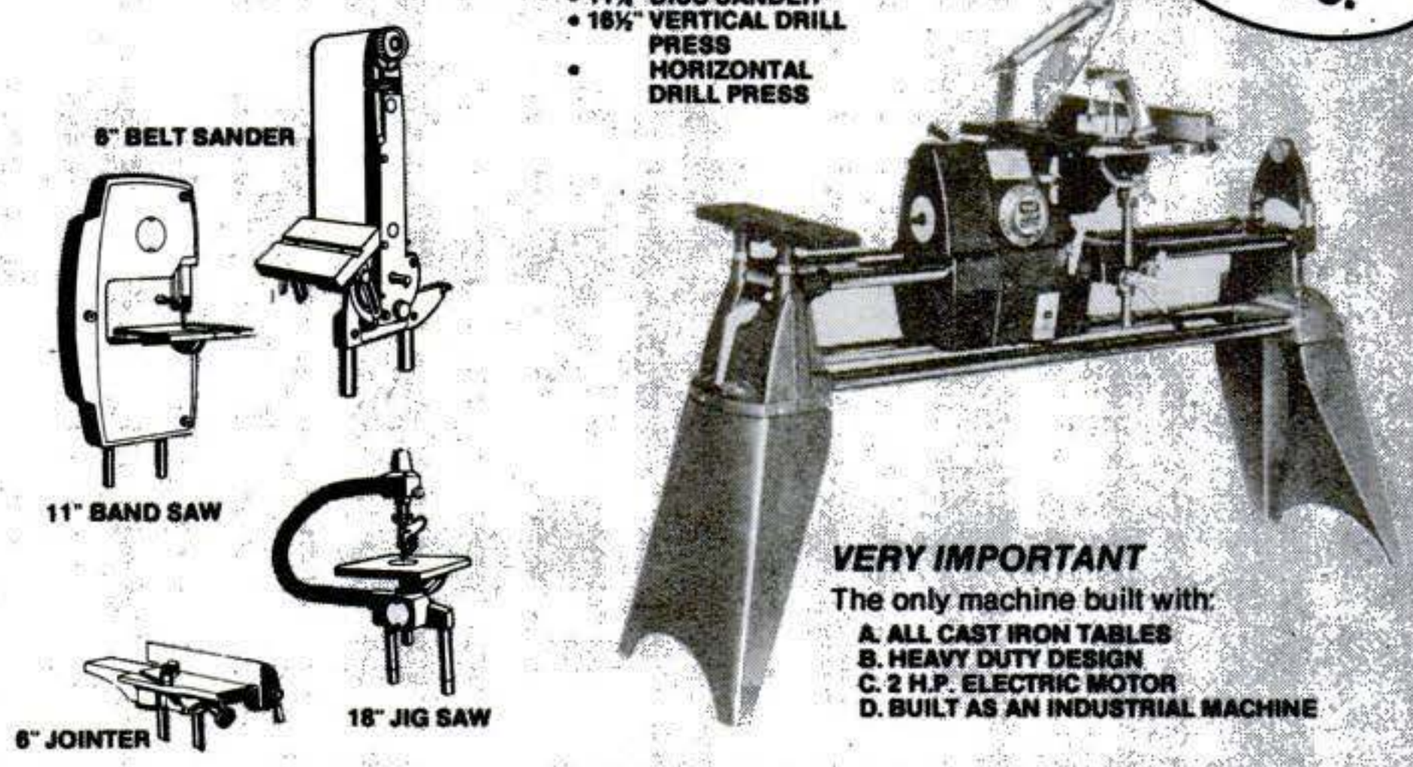

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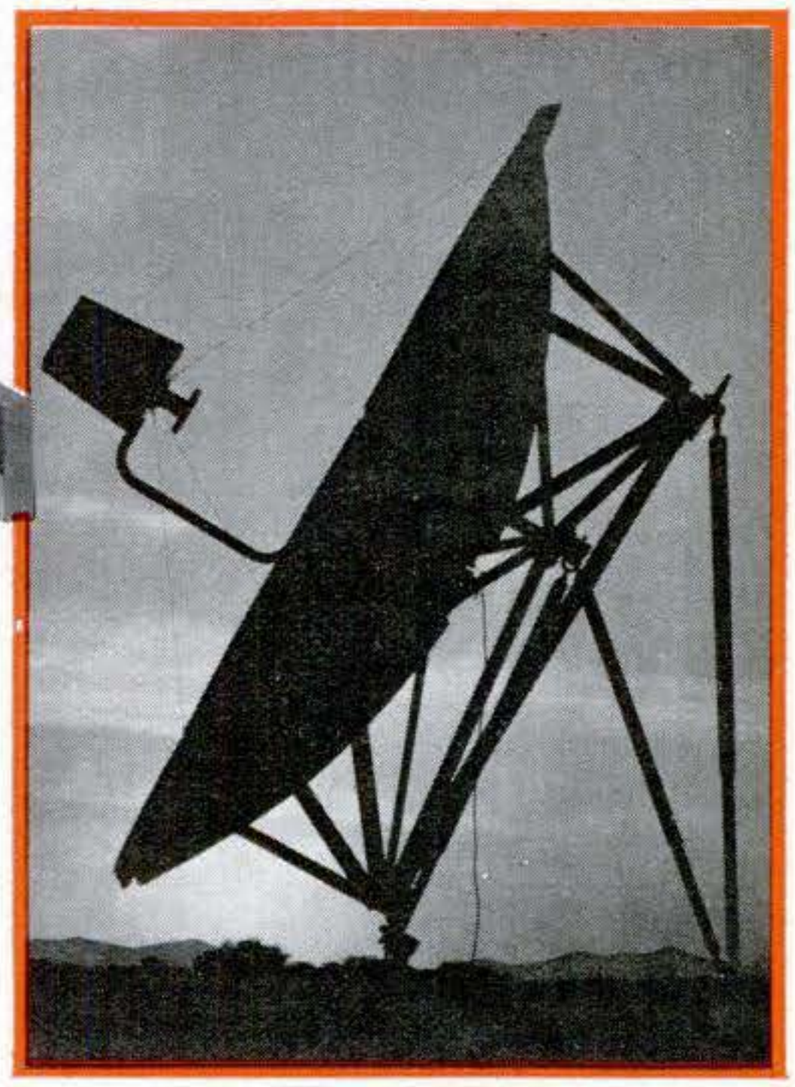

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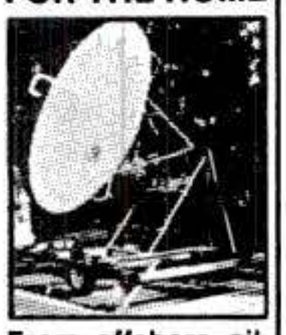

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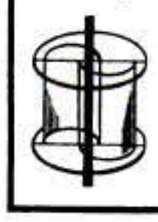

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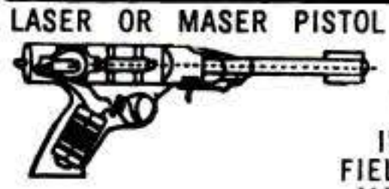

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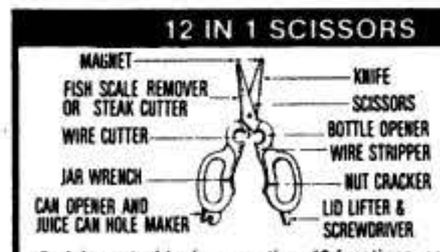

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